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ORDNANCE MEMORANDA NO. 17.



GATLING GUNS.

ORDNANCE MEMORANDA.

No. 17.

REPORT

OF THE

BOARD OF OFFICERS

APPOINTED BY

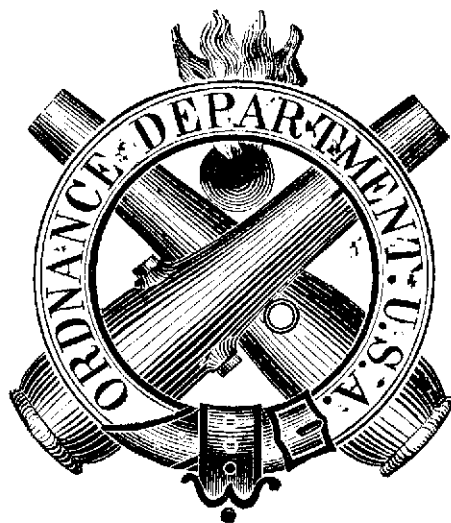
SPECIAL ORDERS No. 108, A. G. O., MAY 31, 1873

ON

GATLING GUNS OF LARGE CALIBER

FOR

FLANK - DEFENSE.



WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1874.

PROPERTY OF US ARMY

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NEW YORK, *January 16, 1874.*

GENERAL: I have the honor to transmit herewith the report of the board appointed by Special Orders No. 108, War Department, Adjutant-General's Office, Washington, D. C., May 31, 1873, "to decide upon the caliber of guns to be tried, and the ammunition to be used, in the experiments and tests of two Gatling guns of large caliber for flank-defense of fortifications," &c., &c.

The minutes of the proceedings of the board form a part of the report.

The board desire to express their sense of the obligations they are under to Col. W. F. Barry, commanding the artillery school, and to Maj. T. G. Baylor, commanding the arsenal at Fortress Monroe, for facilities afforded and courtesies extended to the board during the trials.

Very respectfully, your obedient servant,

Q. A. GILLMORE,

Major of Engineers, Bvt. Maj. Gen., President of Board.

The CHIEF OF ORDNANCE, U. S. A.,

Washington, D. C.

REPORT.

MINUTES OF THE PROCEEDINGS OF A BOARD CONVENED AT HARTFORD, CONN., BY VIRTUE OF THE FOLLOW- ING ORDER:

[Special Orders No. 108.—Extract.]

WAR DEPARTMENT, ADJUTANT-GENERAL'S OFFICE,
Washington, D. C., May 31, 1873.

* * * * *

2. A board to consist of Maj. Q. A. Gillmore, Corps of Engineers; Maj. T. J. Treadwell, Ordnance Department; Capt. Lorenzo Lorain, Third Artillery, is appointed to meet at Hartford, Conn., on the 5th day of June, 1873, or as soon thereafter as practicable, to decide upon the caliber of guns to be tried, and the ammunition to be used, in the experiments and tests of two Gatling guns of large caliber for flank-defense of fortifications, authorized by act of Congress approved March 3, 1873, published in General Orders No. 44, March 22, 1873, from this Office.

The board will fix upon a programme for the trial, and is authorized to adjourn and meet again, at the call of the president of the board, at such place as may be decided on for the tests and experiments.

The board will make their report to the Chief of Ordnance.

The junior member of the board will act as recorder.

* * * * *

By order of the Secretary of War:

E. D. TOWNSEND,
Adjutant-General.

Official:

J. P. MARTIN,
Assistant Adjutant-General.

HARTFORD, CONN., *June 5, 1873*

The board met pursuant to the foregoing order, all the members being present.

A letter from the Chief of Ordnance and a copy of General Orders No. 44, War Department, Adjutant-General's Office, March 22, 1873, promulgating the act of Congress under which the board was organized, were presented and read by the recorder.

The board then proceeded to the examination of two 1-inch Gatling guns and corresponding ammunition presented by the Gatling Gun Company, and then adjourned to meet in New York City at 10 o'clock a. m., on the 6th.

NEW YORK, *June 6, 1873.*

The board met pursuant to adjournment, all the members being present, and concluded that, before submitting any programme for the experiments and tests, it is desirable to obtain all the official reports and information possible, in reference to the Gatling gun, on file in the Ordnance Department.

The president of the board was requested to obtain the desired information.

The board adjourned to meet at the call of the president.

NEW YORK, *June 20, 1873.*

The board met pursuant to the call of the president, all the members being present.

The president of the board laid before it for consideration a number of official reports of experiments with the Gatling gun, and of competitive trials between the Gatling and other guns, received from the Chief of Ordnance.

[For a list of these reports see "Synopsis of the previous reports and competitive trials with the Gatling gun," page 19.]

The board adjourned to meet at West Point, N. Y., on the 21st instant, for the purpose of ascertaining if a suitable practice-ground could be had at that place.

WEST POINT, N. Y., *June 21, 1873.*

The board met pursuant to adjournment, all the members being present, and after a careful examination concluded that there was no suitable ground for conducting the contemplated tests and experiments in that vicinity.

The board adjourned to meet in New York on the 23d instant.

NEW YORK, *June 23, 1873.*

The board met pursuant to adjournment, all the members being present, and agreed upon the partial programme set forth in the following letter to the Chief of Ordnance:

ARMY BUILDING, NEW YORK, *June 23, 1873.*

GENERAL:

* * * * *

From the information and reports supplied from the office of the Chief of Ordnance, it is thought that two Gatling guns differing very considerably in caliber, the larger firing canister at comparatively short ranges, and the smaller firing solid shot at longer ranges, should be first placed in competition with the 8-inch siege-howitzer and the 12-pounder Napoleon gun.

The Gatling guns recommended for trial are the 1-inch and the 0.42-inch calibers.

AMMUNITION.

The board recommends that ammunition be prepared as follows:

For the 1-inch Gatling gun:

- 1,000 rounds of canister made with 18, or, better, if possible, with 21 balls of same size as now used, reducing end of cartridge to facilitate feeding, omitting large ball, and closing end with pasteboard wad.
- 1,000 rounds of canister made as above, substituting for the balls lead cylinders of the same diameter and length as the balls. The standard length of cartridge will fix the number of tiers of cylinders.
- 2,000 rounds of canister as now made.
- 1,000 rounds of solid shot as now made.

For the 0.42-inch Gatling gun:

- 5,000 rounds hardened projectiles.

For the 8-inch siege-howitzer :

50 rounds service-canister.

50 rounds special canister of the same length and weight as service-projectile, but filled with lead balls, five to the pound.

For the 12-pounder Napoleon gun :

50 rounds of service-canister.

50 rounds of special canister of same length and weight as service-projectile, but filled with lead balls, eleven to the pound.

50 rounds of spherical case.

TARGETS.

One frame and canvas target 9 feet by 45 feet, suitably divided into squares by horizontal and vertical lines, with extra canvas for renewing the cover.

One penetration target.

The board submit this as a partial programme only, to be supplemented by such additional trials as may suggest themselves during the first series of experiments, and recommend that the guns, ammunition, and other materials specified above, be sent to the commanding officer of the arsenal at Fortress Monroe, with instruction to extend to the board such necessary assistance as they may require in conducting the trials.

Very respectfully, your obedient servant.

Q. A. GILLMORE,

Major of Engineers, Brevet Major-General,

President of Board.

To the CHIEF OF ORDNANCE, UNITED STATES ARMY,

Washington, D. C.

The board adjourned to meet at Fortress Monroe at the call of the president.

FORTRESS MONROE, VA.,

September 30, 1873.

The board met pursuant to the call of the president, all the members being present.

The president of the board laid before it a letter from the Chief of Ordnance, approving the programme as recommended by the board.

The board then proceeded to the trials set forth in their programme ; for the general results of which see the body of the report and accompanying targets. The board being dissatisfied with the performance of the time-fuses, recommended additional trials as set forth in the following letter to the Chief of Ordnance :

NEW YORK, *October 6, 1873.*

GENERAL: I have the honor to report that the board for testing the Gatling guns met at Fortress Monroe, Va., on Tuesday, the 30th ultimo, prosecuted their labors until Saturday evening, the 4th instant, and then adjourned without bringing their trials to a close.

The competitive trials with 8-inch canister, within suitable range for that kind of projectile, were satisfactory and conclusive ; but at longer ranges the results were uniformly bad, with case-shot, from both the 8-inch howitzer and 12-pounder Napoleon gun, owing to bad fuses.

The board are unanimously of the opinion that the trials should embrace ranges of 800, 1,000, and even 1,200 yards, for the reasons that, although ranges of 150 to 200 yards will suffice for the flanks of most of our permanent works, longer ranges are necessary for field-works, especially detached works in which the guns in the flanks command the approaches for considerable distances.

After full conference with Colonel Baylor, the board recommend that he be authorized to prepare 30 rounds of case-shot for the 8-inch howitzer and 30 rounds of case-shot for the 4½-inch rifle, with concussion or other fuses, as in his judgment he shall deem best. Colonel Baylor thought he could get this ammunition ready by the last week of the present month.

Very respectfully, your obedient servant,

Q. A. GILLMORE,

Major of Engineers, Brevet Major-General,

United States Army, President of Board.

Brigadier-General A. B. DYER,

Chief of Ordnance, United States Army,

Washington, D. C.

Colonel Baylor was also requested to construct ten targets of one-inch yellow-pine boards, each 6 feet high and 50 feet long, to represent a column of infantry, by companies at full distance, approaching or retiring from the

battery, the nearest company being 1,000 yards from the gun. The targets to be placed behind each other in succession 50 feet apart.

The board adjourned to meet at Fortress Monroe at the call of the president.

FORTRESS MONROE, *November 11, 1873.*

The board met pursuant to the call of the president, all the members being present, and proceeded to continue the trials in accordance with the approved programme; the results of which are given in the body of the report and the accompanying targets.

The board adjourned to meet at call of the president.

NEW YORK, *December 20, 1873.*

The board met pursuant to the call of the president, all the members being present, and proceeded to a discussion of the results of the trials, and the preparation of their report. Having agreed upon the recommendations to be made, the form of report, and the character of the drawings and diagrams of targets to accompany the same, the board adjourned to meet again at the call of the president, should another meeting be deemed necessary, otherwise the report to be sent by the president to the other members for their signatures.

No subsequent meeting was held.

The Gatling gun, shown on its carriage in Fig. 1, may be described as consisting of a number of very simple breech-loading rifled barrels grouped around and revolving about a common axis, with which they lie parallel. These component barrels are loaded and fired while revolving, the empty cartridge-shells being ejected in continuous succession. Each barrel is fired only once in a revolution, but as many successive shots are delivered during that time as there are different barrels, so that the ten-barrel Gatling gun fires ten times in one revolution of the group of barrels. The action of each part is therefore quite deliberate, while collectively the discharges are frequent. The working of the gun is simple. One man places one end of a feed-case full of cartridges into a hopper at the top of the gun, while another man turns a crank by which the gun is revolved. As soon as the supply of cartridges in one feed-case is exhausted, another case may be substituted without interrupting the revolution or the succession of discharges. The usual number of barrels composing the gun is ten. The mechanism by which the described results are effected is simple, and can be readily understood from the following description and the accompanying plates.

The ten barrels are grouped around a central shaft, and parallel thereto. The bore of each barrel extends through from end to end, and the breech is chambered to receive a flanged "center-fire" metallic-case cartridge. The breech ends of all the barrels are firmly screwed into a disk or rear barrel-plate, which is fastened to the shaft, while the muzzles pass through another similar disk, called *front barrel-plate*, on the same shaft. The shaft is considerably longer than the barrels, and projects beyond the muzzles, while it extends backward for some distance behind the breeches of the barrels. Directly behind the open barrels a hollow cylinder of metal, called a *carrier-block*, is fastened to the shaft, and in the exterior surface of this carrier-block ten semi-cylindrical channels are cut, which form trough-like extensions of the cartridge-chambers of the barrels to the rear, and are designed to receive and guide the cartridges while they are being thrust into the barrels, and to guide the empty cases while they are being withdrawn. Behind the *carrier-block* the shaft carries another cylinder, called the *lock-cylinder*, in whose surface ten guide-grooves are formed, which are in line with the barrels, and in which slide ten long breech-plugs or locks, called *lock-tubes* or *plungers*, by which the cartridges are thrust into the barrels, and which close the barrels and resist the reaction of the charges when they are fired. This cylinder

is called the *lock-cylinder* because each plug or lock contains a spiral main-spring acting on a firing-pin or hammer, by which the charge is fired, so that the plug performs all the functions of a gun-lock, as well as of a breech-plug. The shaft to which the group of barrels and both the carrier-block and the lock-cylinder are rigidly attached is free to turn on its axis, the front end being journaled in the front part of the frame and the rear end in a diaphragm in the *breech-casing*. The breech-casing extends to the rear far enough to contain not only the *diaphragm* through which the main shaft is journaled, but also to form in the rear of the diaphragm a cover for the gearing by which the shaft is revolved. This mechanism or gearing consists simply of a toothed wheel fastened to the shaft and worked by an endless screw on a small axle which passes transversely through the case at right angles to the shaft, and is furnished outside the case with a hand-crank. A casabel plate closes the end of the case. Each breech-plug or lock carries a hooked *extractor*, which snaps over and engages the cartridge-flange when the plug is pushed forward, but which, when the plug retreats, withdraws and ejects the empty case. The *cartridge carrier-block* is covered above the frame by a semi-cylindrical shell, which is provided at the top with an opening of suitable size and shape to permit a single cartridge to fall through it into one of the channels of the carrier-block, which it overlies. There is a suitable trough extending upward from this opening and forming a *hopper*, in which a straight feed-case can be placed in a vertical position, containing a number of cartridges lying lengthwise across the case, one above another. Beneath the *carrier-block* everything is open, so that the cartridges or shells which are withdrawn by the extracting-hooks from the barrels fall to the ground. Within the cylindrical breech-case attached to the frame a heavy ring not quite the length of the lock-cylinder is fastened to the case and diaphragm, which nearly fills the space between the inside of the case and the cylinder. Portions of the inside of this ring are so cut away as to leave a truncated, wedge-shaped, annular or spiral *cam* projecting from the inner surface of the ring, having two helicoidal edges inclined to each other and united by a short, flat plane. Against these edges the rear ends of the locks or breech-plugs continually bear, there being room enough for the locks to lie loosely within the parts of the ring which are cut away. The apex of the wedge-shape cam points to the barrels. Each lock is held back against the cam by a lug or horn projecting laterally from the end

of the lock and entering a groove formed at the base of the cam, in the thin part of the ring.

The shape and position of the cam and grooves may be better understood by reference to the diagram, Fig. 2, which shows the cam-ring as it would appear if cut open and spread out flat, the lines A and C being the development of the edges of the helicoidal cam surfaces, B that of the plane surface connecting these, and *a* and *c* the grooves for holding and drawing back the locks. The ten locks are shown in their relative positions abutting against the cam surfaces, six of them being shown in section.

It will be seen that the points of the firing-pins or lock-hammers, H, protrude beyond the front of the locks while the spindles project from the rear, where they are fashioned into knobs by which the hammers are drawn backward and cocked while passing through the groove in the rib, D.

The diagram shows that the distance of the apex B of the cam from the ends of the barrels is such that the breech-plugs or locks exactly fill the space, so that each plug there forms an abutment which closes the breech of its barrel and abuts against the apex of the cam, which serves to resist the recoil of the plug when the charge is fired. It will be remembered that the locks are guided in grooves formed in the *lock-cylinder*, and therefore cannot deviate from their alignment with the barrels. The *lock-cylinder* and the cartridge *carrier-block* could not be shown in the diagram, because if they were spread out as the locks are they would cover them and hide them from view. From what has before been explained it will be understood that the ten barrels, the cartridge carrier-block, and the lock-cylinder carrying its ten locks, all shown together in Fig. 3, will, by turning the crank, revolve together about the axis of the central shaft, the lock-cylinder revolving within the stationary case and cam-ring, and the cartridge carrier-block revolving beneath the half cylindrical shell which carries the hopper. Fig. 4 shows the frame which encases the gun, with the trunnions, breech-casing, and hopper for feeding the cartridges. The cartridges will, as the carrier-block channels come successively under the hopper, drop into the channels in front of the locks and be kept in place by the hopper-shell. The revolution of the lock-cylinder carries the locks around with it and causes them to receive a longitudinal reciprocal motion by their ends sliding along the inclined surfaces of the stationary cam. Each lock, then, one after the other, is pushed forward toward its barrel. As the revolution of the parts keeps the locks in contact with the advancing side of the cam, each lock in succession closes

its barrel, and its longitudinal motion ceases, while it passes the flat surface of the cam, and then each slides backward from its barrel when constrained to move along the retreating side of the cam by the corresponding cam-groove, and so on, each lock repeating these movements at each successive revolution of the shaft.

The position of the cam relatively to the cartridge-hopper is such that each lock is drawn backward to its full extent when it passes the hopper, so that the cartridges may fall into the carrier in front of the locks. The explosion of each cartridge takes place as its proper lock passes over the flat apex of the cam which resists the recoil.

The hammer is cocked by the knob or head at its rear end coming into contact with a flat *rib* located inside of the cam, as shown on the diagram at D. This rib restrains the hammer from moving forward, while the forward movement of the body of the lock continues; the spiral mainspring is compressed until the revolution carries the hammer-knob beyond the end of the cocking-rib, when the hammer will spring forward and strike with its point the center of the cartridge-head and explode the charge. The point in the revolution at which the barrels are discharged is below and at one side of the axis. The diagram shows the ten locks each in a different part of its cycle of action. At I the cartridge has just dropped in front of the lock, at II it has been pushed forward somewhat, at III the point of the cartridge has entered the barrel, at IV it is pushed nearly home, and the head of the hammer is retained by the cocking-rib, II, the mainspring being partly compressed. At V the lock has reached the flat part of the cam, the cartridge is pushed quite home, and the mainspring has been fully compressed by the retention of the hammer by the cocking-rib, the end of which is just reached by the hammer, which is about being released. At VI the hammer having been released has sprung forward and exploded the cartridge, the end of the lock or breech-plug being firmly braced against the flat surface, B, of the cam. At VII the lock has commenced to retreat, and at VIII it has partially withdrawn the empty cartridge-shell from the barrel. At IX it has completely extracted the shell, which is falling away from the gun. At X the lock is fully drawn back and is about to pass again into its first position. Thus it will be seen that in the ten-barrel gun one revolution of the barrels corresponds to one revolution of the locks, and delivers ten shots, a process which is repeated continuously so long as the crank is turned and the cartridges supplied. The gun can be unloaded of

any cartridges not fired by removing the feed-case, opening the hopper, and reversing the motion of the crank. The locks are made interchangeable and are strong and durable, but should they get out of order the gun is so constructed that any one or all of them can be, in a few moments, taken out and others inserted in their places, and so the gun can be kept in perfect working order at all times on the field of battle. In the new model the mechanism of the locks has been greatly strengthened, as well as otherwise improved, and there are means provided for their insertion and removal without taking off the cascabel-plate. These means consist of the perforation of the covering and back diaphragm in the outer casing, and by the closure of the apertures through both these plates by a single removable plug, as shown above the knob of the cascabel in Fig. I. This is a very valuable improvement, inasmuch as the repairing or inspection of the locks is thereby greatly facilitated. The absence of one or more locks does not affect the working of the gun except to diminish the intensity of fire in proportion to the number of locks removed. For each lock removed, however, one unexploded cartridge falls to the ground at each revolution of the gun. The gun is encased in a frame which has trunnions, and is mounted in the ordinary way, like a field-piece. The screw for elevating and depressing the breech works in a nut attached to the trail of the carriage in the usual way. An automatic traversing apparatus is applied, by which a limited angular movement in a horizontal plane may be given to the gun, as follows: A cylinder having a cam-groove in its periphery is applied to the crank-axle, and the end of a cylindrical pin enters this groove. The cylindrical pin is attached to an arm which is connected to the elevating screw; when the crank is turned the cam-groove travels back and forth on the cylindrical pin, swinging the gun from side to side through a sector of three degrees. The pin may be thrown out of gear with the cylinder and the gun be fired without swinging. The sector, covered automatically by the oscillator, may be changed about five degrees on each side without moving the trail or suspending the firing. The cases which contain the cartridges, and which are applied to the hopper when it is desired to feed the gun, are long narrow boxes of sheet-tin open only at the lower ends. The cross-section of the case is trapezoidal, the edge next to which the heads lie being much wider than the cartridge-heads, while that which receives the points of the balls is of the width of the ball. This form enables all the cartridges in the case to assume a horizontal position, because the heads of the con-

tiguous cartridges have room to roll over slightly, so as to lie partly alongside of each other, while the ball-ends are kept vertically over each other. For drawing of feed-case see Fig. 5. The supply of cartridges to the gun may also be made by what is called the "*feed-drum*." The straight feed-cases each contain forty cartridges. The feed-drum (used only with the smaller calibers) contains sixteen radial sections grouped vertically about the axis of the drum, each section holding twenty cartridges, or three hundred and twenty cartridges to each drum. The number of sections in the drum and the number of cartridges in each section may be varied. The drum rests vertically over the hopper and feeds the cartridges automatically, from the several sections in succession. The principal objection to the drum consists in the greater number of cartridges which it exposes to an enemy's fire and the inferior facilities which it affords for packing and transporting the ammunition. The straight feed-cases are deemed to possess superior advantages, and are recommended for all calibers.

Weights of the Gatling 10-barrel guns.

	Pounds.
1-inch caliber.....	650
0.75-inch and 0.65-inch caliber.....	450
0.55-inch caliber.....	400
0.50-inch, 0.45-inch, and 0.42-inch caliber, with long barrel.....	200
Same calibers with short barrels.....	135

Weights of carriages for Gatling 10-barrel guns.

	Pounds.
Carriage for 1-inch gun:	
Weight of limber and box.....	790
Weight of gun-carriage.....	1, 152
Total.....	1, 942
	Pounds.
Carriage for 0.42-inch, 0.45-inch, and 0.50-inch guns.	
Limber complete.....	387
Gun-carriage complete.....	326
Total.....	713

Weight of empty feed-drum for 0.42-inch-caliber gun, 25 pounds; weight of same filled with 400 cartridges, 60 pounds; weight of empty feed-case for 0.42-inch-caliber gun, 2 pounds 6 ounces; weight of same filled with 40 cartridges, 5 pounds 15 ounces.

The limber for the 0.42-inch gun will hold 50 cases, or 2,000 cartridges.

Aggregate weight of 0.42-inch-caliber gun, gun-carriage, limber, and 2,000 cartridges in feed-cases, 1,210 pounds. Weight of 5,000 extra 0.42-inch cartridges (1,000 in a box) and 5 packing-boxes, 496 pounds.

12-pounder Napoleon, (bronze, caliber 4.62.)

	Pounds.
Weight of gun and limber, with implements	3, 895
Weight of ammunition in limber-box when full, (32 rounds)	497
Weight of tarpaulin	36
Weight of gun and limber, with ammunition packed	4, 428

8-inch siege-howitzer.

	Pounds.
Weight of gun-carriage and limber	3, 919
Weight of gun	2, 614

Total 6, 533

There is no limber-box.

4½-inch rifle.

	Pounds.
Weight of gun-carriage and limber	3, 641
Weight of gun	3, 450

Total 7, 091

There is no limber-box.

AMMUNITION FOR GATLING GUNS.

The Gatling guns are designed to be served with ordinary center-fire metallic-case cartridges, in order that the ammunition shall be interchangeable with that for small arms of the same caliber.

For the 1-inch-caliber gun, in addition to the cartridge containing a single solid projectile, a canister-cartridge has been used, containing 15 lead balls, each weighing 141 grains, terminating in front with a one-inch half-round projectile weighing 1,287 grains.

The total weight of this 1-inch canister-cartridge is 5,190 grains

The 1-inch solid ball cartridge is made up as follows:

	Grains.
Projectile	3, 942
Metallic case	1, 382
Powder	500
Lubricant	51

Total 5, 875

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No description of the ammunition for the several calibers is deemed necessary, except that used during the trials.

AMMUNITION USED BY THE BOARD.

With the 0.42-inch Gatling gun.

One trial was made with cartridges containing two balls. In all the other trials but one ball was used; the ammunition being known as the "Berdan Center-Fire Metallic Case Cartridge," the weight of the component parts being as follows:

	Grains
0.42-inch-caliber projectile.....	370
Metallic case and lubricant	163
Powder, (Hazard's Gatling powder No. 1).....	77

Total weight of 0.42-inch-caliber cartridge, (see Fig. 6).... 610

With the 1.00-inch-caliber Gatling gun.

Two kinds of special canister ammunition devised by the board were used; one containing 21 round lead balls and the other 18 cylindrical slugs. The weights of the component parts, for each, are given below:

Spherical canister for 1.00-inch Gatling gun.

	Grains.
21 lead balls, each 0.45 inch diameter and weighing 141 grains....	2,961
Metallic case	1,413
Powder	375
Wads and lubricant, about	170

Total weight of canister-cartridge with spherical ball, (see Fig. 7)

4,919

Cylindrical slug canister for 1.00-inch Gatling gun.

	Grains.
18 cylindrical slugs, each 0.45 inch diameter and 0.45 inch long and weighing 199 grains.....	3,582
Metallic case	1,496
Powder	375
Wads and lubricant, about.....	90

Total weight of canister-cartridge with cylindrical slugs,

(see Fig. 8)

5,543

A few trials were made with a 1-inch-caliber percussion shell. (See Fig. 9.)

With the 8-inch siege-howitzer.

Ordinary-service canister, containing 48 iron balls, each 1.85 inch diameter and weighing 0.86 pound; total weight of canister, $53\frac{1}{2}$ pounds.

Spherical case No. 1, containing 486 lead balls, each 0.69 inch diameter and weighing 14 to the pound; total weight of one case-shot, fixed, 59½ pounds.

Spherical case No. 2, containing 470 lead balls, 14 to the pound; weight, fixed, 60 pounds 3 ounces.

Special canister No. 1, devised by the board, containing 208 lead balls 0.977 inch diameter, (5 to the pound;) total weight of canister, 54 pounds.

Special canister No. 2, devised by the board, containing 440 lead balls 0.75 inch diameter, (11 to the pound;) total weight of canister, 54 pounds.

With the 12-pounder Napoleon gun.

Special canister, devised by the board, containing 121 lead balls 0.75 inch diameter, (11 to the pound;) total weight of canister, 14½ pounds.

Spherical case, containing 82 lead balls, each 0.69 inch diameter and weighing 14 to the pound; total weight of one case-shot, fixed, 14.7 pounds.

With the 4½-inch caliber rifle.

Service-shrapnel, (with Schenkl percussion-fuse,) containing 168 lead balls 0.69-inch diameter, weighing 14 to the pound; total weight of case-shot, 32 pounds.

The Bormann fuse was used during the first trials, with the spherical case, from both the 8-inch howitzer and the 12-pounder Napoleon gun.

During the last experiments the ordinary paper-fuse was used.

SYNOPSIS OF PREVIOUS REPORTS AND COMPETITIVE TRIALS WITH THE GAT-LING GUN.

"Report on Gatling's improved battery-gun," made by Lieut. I. W. Maclay, First Artillery, Washington arsenal, January 20, 1865, giving a description of the 4-barreled 0.58-inch gun.

[The trials were for accuracy at 100, 300, and 500 yards, also for rapidity of firing and penetration. Target was 10 feet by 10 feet.]

Range in yards.	Number of shots fired.	Number of hits.	Remarks.
100	20	20	Twenty shots fired in eight seconds.
300	20	20	Penetration at 300 yards through eleven inches of pine, (probably white pine.)
500	20	18	

"In the event of one barrel or lock becoming disabled the gun is still efficient, as was proved by continuing the trials after one barrel had burst. All the parts of the gun worked well."

"The gun certainly possesses the advantages of rapidity and accuracy."

"There is no escape of gas, but, like all fire-arms, there is a recoil."

General suggestions in regard to the twist and depth of the grooves, also as to the weight of the carriage. (Second report by the same officer, March 9, 1865, containing a partial description of the 6-barreled Gatling gun.)

"Report on the Gatling repeating-gun," made by Bvt. Lieut. Col. D. H. Buel, United States Ordnance, Frankford arsenal, March 16, 1866, containing a record of the firing of the 1-inch Gatling gun, smooth-bore, with canister.

Range in yards.	Number of rounds.	Number of projectiles.	Number of hits.	Remarks.
100	12	192	180	Target 35½ feet by 15 feet, made of inch pine boards.
150	12	192	123	
200	12	192	64	About 25 per cent. failed to penetrate the target.
250	12	192	34	About 50 per cent. failed to penetrate the target.

"The gun worked smoothly in all its parts; the cartridges were fed and the cases thrown out with ease and certainty." "Out of 342 cartridges there were but 4 failures."

"Report of the competitive trials of the Gatling 1-inch caliber rifled gun and the 24-pounder flank-defense howitzer," made by Bvt. Lieut. Col. T. G. Baylor, United States Ordnance, at Fortress Monroe arsenal, July 14, 1866.—"I consider it a superior arm to the 24-pounder howitzer for flank-defense, as from 80 to 100 buck-and-ball cartridges can be fired in 1 minute and 30 seconds, being a discharge of 1,200 to 1,600 projectiles, while from the 24-pounder only 4 rounds, giving for canister 192 and for case-shot 700 projectiles in the same time."

"The machinery of this gun is simple and strong; I do not think it likely to get out of order." "The size of the bore might be increased to advantage."

Range in yards.	Number of rounds fired.	Number of projectiles.	Number of hits.	Remarks.
800	110	110	49	Firing solid shot. Target 24 feet by 6 feet.
1,000	92	92	50	Firing solid shot. Target 12 feet by 12 feet.
1,200	87	87	22	Firing solid shot. Target 12 feet by 12 feet.
200	73	1,168	278	Firing canister. Target 48 feet by 6 feet.
200	74	1,184	322	Firing canister. Target 48 feet by 6 feet.
150	101	1,616	691	Firing canister. Target 48 feet by 6 feet.
100	29	464	291	Firing canister. Target 48 feet by 6 feet.

“Report of the trials with the center-fire cartridge in the Gatling gun,” made by Bvt. Lieut. Col. S. V. Benét, United States Ordnance, at Frankford arsenal, November 10, 1866.—“The firing was an entire success; the working of the gun was perfect.” “I consider that the center-fire arrangement and the use of the center-fire cartridges add 100 per cent. to the value and efficiency of the gun.”

“Report on certain defects in the Gatling gun,” made by Lieut. J. G. Butler, United States Ordnance, at Leavenworth arsenal, October 2, 1867, calling attention to the fact that the “barrels were successively discharged before they had fairly cleared the front transverse bar of the gun-frame, and that it was not the undermost barrel that fired,” and suggests certain changes so as to cause the firing to take place when the barrel is at a lower position.

“Report on the Gatling gun,” made by Lieut. C. E. Dutton, United States Ordnance, at Watervliet arsenal, October 12, 1867, giving the results of the trials for the purpose of “ascertaining at what precise point in the revolution of the barrels the fire is delivered when turned very slowly, and how much alteration takes place in the relative position of that point when turned rapidly,” stating that in slow firing the ball from the inch-gun clears the bar by 3-16 of an inch, and that of the $\frac{1}{2}$ -inch gun by 1-6 inch; a more rapid motion causes the firing to take place at a lower point.

General Hagner, United States Ordnance, in the letter transmitting the above report, suggests certain changes in the mechanism of the gun so as to cause each barrel to deliver its fire when in its lowest position.

“Report on the Gatling gun,” by Alfred Gibbs, major of Seventh Cavalry, Fort Leavenworth, March 16, 1868, considering “the carriage, limbers, and caissons vastly too heavy for the weight they are intended to carry,” and suggesting lighter ones; stating that the lateral position of the firing-barrel causes a deflection in the line of fire in rapid firing, and also calling attention to the “slugging of the balls on the front transverse bar.”

“Report on the Gatling gun,” made by Bvt. Brig. Gen. P. V. Hagner, United States Ordnance, Watervliet arsenal, April 3, 1868, being a reply to the

report of Major Gibbs, Seventh Cavalry, and considering the carriage, &c., sufficiently light.

“Report on Gatling gun,” made by Bvt. Col. J. G. Benton, United States Ordnance, Hartford, July 3, 1871, being an inspection-report, and contains a description of the new “drum-feed.”

“Report of target-practice with the 1-inch Gatling gun” at the Artillery School at Fortress Monroe for the summer of 1871, made by Bvt. Maj. Gen. William F. Barry, colonel Second Artillery.

Range in yards.	Projectiles.	Number of rounds fired.	Proportion of hits.	Remarks.
200	Solid shot	100	$\frac{3}{4}$	Target 6 feet by 6 feet.
300	Solid shot	100	$\frac{3}{4}$	Rate of fire: 70 to 80 shots per minute.
400	Solid shot	100	$\frac{1}{2}$	
500	Solid shot	100	$\frac{1}{2}$	
600	Solid shot	100	$\frac{1}{2}$	
200	Canister.....	100	$\frac{1}{2}$	The canister is apparently worthless beyond 200 yards; at 200 yards it is not very effective; at 150 yards there are many hits, but the pellets are too light to be valuable.

“Report of target-practice with the $\frac{1}{2}$ -inch Gatling gun” at the Artillery School at Fortress Monroe, Va., February 11, 1873, made under the direction of Bvt. Maj. Gen. W. F. Barry, colonel Second Artillery. Range, 900 yards; target, 24 feet by 6 feet; projectile, solid shot; number of rounds fired, 555; number of hits, 41; with the feed-drum 400 shots were fired in 1 minute and 10 seconds, with two instances of a cartridge fouling and causing delay.

“Report on the use of the feed-drum with the Gatling gun,” made by Bvt. Maj. Gen. William F. Barry, Artillery School, Fortress Monroe, July 8, 1873.—“I consider a feed-drum of some sort to be a most useful, perhaps essential, appendage to the $\frac{1}{2}$ -inch Gatling gun;” also suggests certain improvements in the drum.

“Report (dated October 28, 1870) of experiments with the Montigny mitrailleuse and Gatling gun,” at Shoeburyness, England, in August and September, 1870.—In the following experiments, the first was: “Firing against time (two

minutes) at a line of targets 9 feet by 9 feet, representing 90 cavalry or 150 infantry." The second, firing five rounds deliberately; target same as before. The third, at 1,200 and 1,400 yards, "firing against time, (two minutes,) at a column of targets 9 feet by 9 feet, representing 90 infantry divided into three companies, 20 yards apart." At 2,070 yards the same targets were arranged to represent 36 cavalry or 45 infantry, divided into 3 troops or companies, 20 yards apart, firing as before. At 2,100 yards, firing at a line of the same targets representing 30 cavalry or 50 infantry.

Kind of gun.	Projectile.	Range in yards.	Number of rounds.	Number of hits.	Range in yards.	Number of rounds.	Number of hits.	Range in yards.	Number of rounds.	Number of hits.	Range in yards.	Number of rounds.	Number of hits.
FIRST EXPERIMENT.													
Mitrailleuse.....	37 solid shot.....	300	5	171	600	6	127	800	5	154	1,000	6	33
Gatling gun, 0.42 inch.....	Single solid shot.....	300	616	369	600	657	522	800	357	299	1,000	423	62
12-pounder field-gun, B. L. R.....	Case.....	300	9	268									
Do.....	Shrapnel.....				600	7	142	800	6	152	1,000	7	218
Do.....	Segment.....							800	6	38			
9-pounder field-gun, M. L. R.....	Case.....	300	10	268									
Do.....	Shrapnel.....				600	7	283	800	5	118	1,000	8	294
Martini-Henry rifle.....	Single solid shot.....	300	141	74	600	146	52	800	136	66	1,000	124	47
Snider rifle.....	do.....	300	23	63	600	95	63	800	102	48			
Gatling gun, 1 inch.....	do.....							800	316	7			
SECOND EXPERIMENT.													
Mitrailleuse.....	37 solid shot.....	300	5	172	400	5	177	600	5	107	800	5	106
Gatling gun, 0.42 inch.....	Single solid shot.....				400	185	169				800	185	123
12-pounder field-gun, B. L. R.....	Case.....	300	6	138	400	5	118						
Do.....	Shrapnel.....							600	5	164	800	5	203
9-pounder field-gun M. L. R.....	Case.....	300	5	162	400	5	110						
Do.....	Shrapnel.....							600	5	78	800	5	124
Martini-Henry rifle.....	Single solid shot.....	300	129	83	400	122	90	600	115	74	800	117	85
Snider rifle.....	do.....	300	90	74	400	84	61	600	88	63	800	83	62
THIRD EXPERIMENT.													
Mitrailleuse.....	37 solid shot.....	1,200	10	201	1,400	8	68						
Gatling gun, 0.42 inch.....	Single solid shot.....	1,200	326	204	1,400	545	104						
Gatling gun, 0.65 inch.....	do.....				1,400	239	236	2,070	338	164	2,100	305	45
Gatling gun, 1 inch.....	do.....				1,400	255	99	2,070	238	99	2,100	121	12
12-pounder field-gun, B. L. R.....	Shrapnel.....	1,200	5	79	1,400	5	224	2,070	6	41	2,100	5	29
Do.....	Segment.....	1,200	6	173	1,400	7	102	2,070	6	115	2,100	9	73
9-pounder field-gun.....	Shrapnel.....	1,200	6	92	1,400	6	178	2,070	6	35	2,100	7	72
Do.....	Segment.....	1,200	6	99	1,400	7	90	2,070	6	60	2,100	6	52

FOURTH EXPERIMENT

Firing at 134 dummies, placed in loose order on uneven ground, representing broken infantry retiring. The left of line was thrown back; front, 98 yards; average depth, 35 yards. Firing from three positions of un-

known range, the distance being judged by the officers in command. In the field-guns shrapnel only was used.

	First position.			Second position.			Third position.			Remarks.
	Estimated range in yards.	Rounds fired.	Hits.	Estimated range in yards.	Rounds fired.	Hits.	Estimated range in yards.	Rounds fired.	Hits.	
Gatling gun, 0.42 inch.....	300	453	312	650	736	162	950	736	177	The mean time of firing 5 rounds from the field-guns, viz, 2½ minutes, was taken as the period for the other guns.
Mitrailleur.....	330	9	122	655	9	83	950	11	9	
9-pounder M. L. R.	400	5	74	{ 700 to 800 }	5	34	1,000	5	47	
12-pounder B. L. R.....	520	5	29		5	82	960	5	39	
Martini-Henry rifle.....	450	148	65	650	133	49	950	110	38	
Suider rifle	450	109	51	700	108	24	900	96	7	

Result of a competitive trial between the Montigny mitrailleur and Gatling gun, 0.42 inch, at a row of ten 9 feet by 9 feet targets.

At 600 yards, 720 rounds from each, deliberately.

Mitrailleur: time, 4 minutes; hits, 538.

Gatling gun: time, 3 minutes 31 seconds; hits, 618.

At 800 yards, 555 rounds from each, deliberately.

Mitrailleur: time, 3 minutes 8 seconds; hits, 292.

Gatling gun: time, 2 minutes 26 seconds; hits, 439.

In the four experiments above given—

The Gatling gun, 0.42 inch, weighing 3 cwt., expended 492 pounds of ammunition and scored 2,803 hits.

The mitrailleur, weighing 3 cwt., expended 472 pounds of ammunition and scored 1,708 hits.

The 12-pounder B. L., weighing 8 cwt., expended 1,232.5 pounds of ammunition and scored 2,286 hits.

The 9-pounder M. L., weighing 8 cwt., expended 1,013 pounds of ammunition and scored 2,207 hits.

Five sets of single targets, 9 feet by 9 feet, six in each row, representing cavalry and infantry at unknown distances, not less than 1,000 yards.

Twelve-pounder B. L. R.: shrapnel; 5 rounds; hits, 4.

Nine-pounder M. L. R.: shrapnel; 5 rounds; hits, 44.

Gatling gun, 1 inch: solid shot; 270 rounds; hits, 16.

Mitrailleur: 37 solid shot; 10 rounds; hits 3.

Martini-Henry rifle: 182 rounds; hits, 17.

Against time, (2 minutes,) at 800 yards; 3 rows of 45 feet by 9 feet targets, 15 yards apart, representing columns of infantry and cavalry.

12-pounder B. L. R.: segment; percussion fuse; 6 rounds, hits 496.

9-pounder M. L. R.: shrapnel; percussion fuse; 7 rounds, hits 254.

Mitrailleur: 37 solid shot; 11 rounds; hits 81.

Gatling gun, 0.42-inch: single solid shot; rounds 82; hits 191.

The Gatling gun "worked stiffly and fire checked twice by cartridge jamming."

Extracts from the report furnishing the foregoing data.

"OCTOBER 28, 1870.

* * * * *

"The particular points for which the committee claim the superiority of the Gatling gun over the Montigny are as follows:

"1st. Greater destructive effect, owing to the rapidity with which it can be fired.

"2d. Greater command of range; the Montigny system being necessarily restricted to small calibers, whereas the Gatling is equally adapted to large as to small calibers.

"3d. The Gatling gun, so far as the experience of the committee goes, is capable of being worked by fewer men than the Montigny.

"4th. Greater strength and simplicity of mechanism.

"5th. Greater facility of repair, the locks of the Gatling being removable, and easily replaced in a few minutes if out of order or otherwise injured; whereas with the Montigny mechanism a similar accident renders the gun, for the time, unserviceable.

"6th. The greater demoralizing effect produced by the continuity of fire of the Gatling as compared with that of the Montigny.

"7th. The drum arrangement affords a better means of carrying the ammunition uninjured than the plan proposed by Major Fosbery for the Montigny.

"The results of the recent inquiry have fully satisfied the committee of the expediency of introducing a certain proportion of these machine-guns, to act as auxiliaries to the other arms of the service, and, of the several designs which have been submitted for their consideration, including those that have been under trial, they are persuaded that the Gatling gun is the best adapted to meet all military requirements.

"To assist in defending such positions as villages, field entrenchments, &c., the committee feel satisfied that the small Gatling would be found invaluable.

"For the defense of caponnières for covering the approach to bridges or *têtes-de-pont*, for defending a breach, and for employment in advanced trenches or in field-works where economy of space is of the utmost importance, the same sized Gatling would unquestionably be a most effective weapon.

"For naval purposes, the small Gatling would apparently be well adapted for use in the tops of vessels of war, to clear the enemy's decks or open ports; while for gun-boats that carry only one heavy gun, and for boat operations, the medium sized Gatling would be most effective in covering the landing of troops or for service up close rivers.

"The committee are also impressed with the effect produced by the medium sized Gatling 0.65-inch caliber, at long ranges, as compared with that of a field-gun, but looking to the weight of ammunition required to produce this effect, and to the exceptional conditions under which the larger Gatling could be used with advantage in the field, they are satisfied that a gun is far preferable at long ranges, and consequently they do not recommend the introduction of the larger description of Gatling for land service.

"In advocating the introduction of the small Gatling gun, the committee wish it to be distinctly understood that they do not for a moment contemplate their supplanting or displacing a single field-gun, the proportions of which have been laid down by the best military authorities as indispensable for an army in the field.

"The characteristics of the two weapons are essentially different. Except against an enemy in the open field, the fire of a mitrailleuse is comparatively worthless, whereas artillery-fire will search out an enemy from almost any position, whether covered by trees, brushwood, earthworks, or houses, and at distances far beyond the range of a mitrailleuse; but in the open field

and at distances up to 1,200 yards, there is reason to believe that the latter will be found the more destructive, owing to the rapidity and continuity of its fire. * * * *

"We have the honor to be, sir, your obedient servants,

"E. WRAY,

"Colonel R. A., President.

"F. A. FOLEY,

"Captain R. N.

"G. SHAW,

"Colonel R. A.

"H. C. FLETCHER,

"Lieut. Col. Scots Fusilier Guards.

"FRED. BEAUMONT,

"Captain R. E.

"W. H. NOBLE,

"Captain R. A.

"H. HEYMAN,

"Lieutenant-Colonel, Secretary."

"The DIRECTOR OF ARTILLERY, *War-Office, Pall-Mall.*"

The following extracts are taken from the "*Second Report of the (English) Special Committee on Mitrailleurs*," dated November 28, 1871, the 0.65-inch-caliber Gatling gun being under consideration:

"The committee consider that, in addition to its employment on board ships of war, as already recommended, a gun of this caliber would be found excessively useful for the defense of coast-batteries against the attack of boats or for assisting in keeping down the fire of ships, engaging forts at close quarters, or attempting to force a passage by pouring an incessant fire into their ports. Such Gatlings, well served, would effectually put a stop to any attempt at landing, and would be more reliable at short range than field-guns.

"With regard to the small Gatling gun of 0.45 inch: The proper rôle for a gun of this caliber and power appears to the committee to be the defense of intrenched positions and villages, or for covering roads, defiles, bridges, or other narrow places along which an enemy may be expected to pass.

"Looking to the uncertainty of shell-fire, even with the best percussion

or time-fuses, there can be little doubt a body of troops having to advance to the attack of an entrenched position, *over any distance within 1,200 yards*, would suffer far more from Gatling guns delivering an incessant and wide-spread fire of the deadliest *mitraille* than from field-guns.

"The committee are unanimously of opinion that a proportion of Gatling guns, worked by the artillery and not exceeding the weight recommended in their report of 14. 3. '70—viz, 18 cwt—should accompany every army in the field, for the specific purposes above detailed, and that they should be kept with the reserves for the express purpose of increasing infantry-fire at critical moments, in precisely the same way that guns of position are used for strengthening the fire of the field-artillery.

"As a rule, mitrailleurs ("Gatling guns") should invariably be so entrenched as to bid defiance to the fire of field-guns, and be kept masked until the attack is fully developed and the enemy well within effective range. They should be provided with Nolan's range-finders.

"The committee do not share in the apprehension that great inconvenience would be caused to an army in the field by the addition to the reserves of a limited number of Gatling guns drawn by two horses each. The result of their experiments show them that, in proportion to the weight of ammunition to be carried, the destructive effect against troops in the open field of the small Gatling gun, at *ranges within 1,400 yards*, is nearly three times that of the 9-pounder rifled M. L. field-gun, and there is every reason to expect that this so-called 'small Gatling' can be so materially reduced in weight, without detriment to its power and efficiency as to bring it, with its carriage and ammunition, within the powers of a single English cart-horse, thus further lessening the objection to it as inconveniently increasing the impedimenta of an army.

"The committee are decidedly averse to the employment of mitrailleurs for advancing with infantry, or indeed for attacking in any form, except when the enemy is provided with an inferior artillery or no artillery at all.

"An exception should be made in the case of mountain-batteries, for which the 0.45-inch Gatling gun, reduced in weight to 150 pounds, to fire from a tripod, seems eminently adapted as an adjunct to guns notoriously weak in their shrapnel and canister fire. This tripod Gatling gun may likewise prove useful in the tops of ships. In the present stage of the inquiry as regards the employment of the larger kinds of mitrailleurs under experi-

ment in Russia and Austria, the committee recommend no trials, being inclined to doubt if they will ever be found so effective for working with cavalry as the horse-artillery gun.

"The committee think either description of Gatling gun would be found invaluable at a siege for purposes of defense on both sides; for the besiegers, in repelling sorties, in protecting the advanced works, particularly at night, or in assisting to keep down the fire of the place; on the part of the garrison, for sweeping the ditches, defending a breach, or for close fighting of any kind.

"In coming to the above conclusions, the committee have given full weight to the opinions of officers, foreign as well as British, who have had experience of the mitrailleuse in the late war, and they have not overlooked the fact reported by Major-General Walker, in his letter dated Berlin, 4. 10. '71, that a very large majority of the officers of the German army who have been consulted on the subject are against the introduction of the mitrailleuse as a field-gun. With reference to these opinions, the committee would call attention to the following circumstances:

"1. That the Gatling gun was very little used by the French.

"2. That the French mitrailleuse was almost as heavy, and required as many men and horses, as the French field-gun.

"3. That the French appear, by all accounts, to have used their mitrailleurs with little judgment; firing them into all sorts of cover, at very long ranges, and without any special means of ascertaining the distances. They seem also to have frequently neglected the precaution of covering their mitrailleurs, either naturally or artificially, thus laying them open to destruction by the German artillery.

"4. That the Germans had no opportunity of testing the merits of mitrailleurs for defensive purposes, having almost invariably acted on the offensive.

"5. That the Germans have no necessity for considering the question of introducing these weapons, being already well provided with a very large number of French mitrailleurs, which, having recently been tried at Berlin, in comparison with Montigny and Gatling mitrailleurs, have been unanimously pronounced superior to either.

"With regard to the question of protecting the small Gatling with a light iron shield, the committee reserve their opinion until the pattern-gun has been tried."

A trial of the 0.50-inch-caliber Gatling gun (old model) was made at Fort Madison, near Annapolis, Md., October 23, 24, and 25, 1873, under the supervision of Lieut. Commander J. D. Marvin, United States Navy, during which 100,000 United States center-fire cartridges were fired to test the quality of the cartridges and the durability of the gun. The cartridges were made by the United States cartridge factory at Lowell, Mass. The official report of these trials furnishes the following information:

"October 23, 10.33 a. m., commenced firing in the presence of Chief of Bureau of Ordnance and others. Ten drums, each holding 400 cartridges, (making 4,000,) were fired rapidly, occupying in actual time of firing ten minutes and forty-eight seconds. The firing was then discontinued to witness experimental firing of the 15-inch-caliber heavy gun. The firing of the Gatling gun was resumed in the afternoon, when some 28,000 cartridges were fired. Commenced firing at 8.50 a. m., October 24, the gun having been cleaned. One hundred and fifty-nine drums, of 400 cartridges each, making a total of 63,600 cartridges, were fired without stopping to wipe out or clean the barrels. At the close of the firing, which extended over a period of five hours and fifty-seven minutes, although the actual time of firing was less than four hours, the barrels were not foul to any extent; in proof of which a very good target was made at 300 yards range before cleaning the barrels. On the 25th day of October the remainder of the 100,000 cartridges were fired. The cartridges used in these trials contained a solid shot weighing 450 grains and a powder charge of 70 grains, being the service-charge for the 0.50-inch-caliber small-arms."

The report says: "The working of the gun throughout this severe trial was eminently satisfactory, no derangements of any importance whatever occurring."

The report also says that "ten drums (4,000) in rapid succession are, I think, as many as can be safely fired, for after that number of discharges the chambers of the barrels are at a temperature which, by the color test, is above 500 degrees Fahrenheit, a point which, it seems to me, endangers the fulminate in the cartridge within the open diaphragm of the drum. With the use of water, as practiced on the afternoon of the first and throughout the whole of the second day's trial, firing might with perfect safety proceed indefinitely, and at the most rapid rate possible."

The water was supplied by a watering-pot, requiring an additional man, but the report suggests the use of a receiver and siphon rose-head, by which the necessity of an additional man would be obviated.

DISCUSSION AND COMPARISON OF RESULTS.

1. The board have deemed it desirable to place a somewhat liberal construction upon the phraseology of the act of Congress under which they were appointed to conduct the trials herein recorded. The law, as well as the order appointing the board, provides for "experiments and tests of two Gatling guns of large caliber for flank defense of fortifications," leaving to be decided by others what calibers should be tried, and also whether the experiments should be conducted with special reference to permanent works only, or should embrace detached field-fortifications and entrenched lines. The intention has been to make the tests sufficiently comprehensive to justify an expression of opinion as to the value of the Gatling gun for flanking purposes generally, in all kinds of works strengthened by flanks, whether requiring, under existing practices, an artillery armament or otherwise.

The lines of defense in our permanent works are, with one or two exceptions, comparatively short. In works having high counterscarp walls and deep ditches, the effective fire of the casemated flanking-guns is necessarily restricted to sweeping the ditch; in others, where the counterscarp is comparatively low, it can easily protect the terreplein of the covered way and reach the crest of the glacis, while in exceptional cases even the approaches to the work for some distance can be reached and commanded from the flank casemates with, slightly curved, fire delivered over the glacis.

In a few works, indeed, having neither counterscarp nor glacis, the flanking-guns have an unobstructed view of the approaches.

In order to flank the ditches only, ranges exceeding 200 yards will seldom be necessary, and an increase of 50 yards will, in most cases, attain and sweep the covered way.

Whenever the approaches to a permanent work can be seen or reached from the flank-casemates, the latter should of course be armed with guns having as long a range as the case requires, provided their effectiveness for flanking purposes at short ranges is not impaired thereby; one essential condition of such effectiveness being the capacity to deliver a rapid and intense fire at the critical moment.

The lengths of the lines of defense, or the range for flanking-guns, in some of our permanent works are given below.

Fort Warren, Boston Harbor, Massachusetts, has casemated flanks; the greatest range which the flanking-guns have to attain is 160 yards.

Fort Independence, Boston Harbor, Massachusetts, also has casemated flanks; but there being no counterscarp wall to intercept the fire, flanking-guns of long range are applicable.

In the fort at Clark's Point, New Bedford, Massachusetts, the flanking-guns would attain the opposite counterscarp with a range of 84 yards.

The fort at Sandy Hook, New York Harbor, if completed substantially according to the official plan, will have lines of defense on its longest front equal to 267 yards.

Fort Tompkins, New York Harbor, has casemated counterscarp galleries for defending the ditch, the longest range for flanking-guns being 136 yards.

Fort Wadsworth, New York Harbor, has casemated flanks, the longest front being the gorge, where the range to the opposite counterscarp is 165 yards.

Fortress Monroe, Virginia, is partially casemated; the longest range for the flanking-guns, in order to reach the opposite counterscarp, is 208 yards.

Some of the flank-casemates see over the counterscarp and command the approaches, and might advantageously be armed with long-range flanking-guns.

Fort Pulaski, Georgia, has casemated flanks on the gorge-face, to protect the bridge over the ditch; distance from flanks to opposite counterscarp, 168 yards.

Fort Clinch, Amelia Island, Florida, has casemated flanks; longest range, to the crest of the glacis, 191 yards.

This brief list comprises works as unlike each other in relief and general design as the entire catalogue of permanent fortifications designed for the defense of our coast affords. In some, like Fort Wadsworth, the heavy guns, as well as those for flank-defense, are arranged tier above tier, thus concentrating a large armament upon a small area; in others, like Fortress Monroe, the work covers a large space and delivers but one tier of fire from heavy guns. We have not, probably, half a dozen works, either completed, under construction, or projected, having lines of defense exceeding 200 yards in length; and although there are quite a number in which suitable guns in the flank-casemates could command the approaches for a

much greater distance, the necessity for far-reaching flanking-guns in these cases is not deemed imperative, for the reason that the terrepleins of the flanks carry heavy guns, mounted *en barbette*, available for the longer ranges. There would seem, therefore, to be no existing reason for the substitution of long-range for short-range guns in the casemated flanks of our permanent works, unless we shall secure thereby a more intense fire at short range than we now possess, and that, too, without sacrificing any essential feature of the existing method of flank-defense by howitzers. One feature of the defense by howitzers is their capability of throwing shells. These are sometimes necessary for sweeping away temporary works improvised by an enemy's column, to cover their approach, especially in crossing the ditch in an open assault. When the barbette-guns can be relied upon for this purpose, the necessity for retaining shell-guns only in the flank-casemates is not obvious. In the general case, however, as preliminary to any open assault except a *coup-de-main*, either the barbette-fire of the besieged is destroyed or arrangements are made to keep it subdued or silent during the critical period of the attack.

2. In field-fortifications, whether the guns for flank-defense are arranged to fire through open embrasures between merlons or otherwise, they generally command the approaches for a considerable distance; and a gun that can deliver a rapid and intense fire, effective at both long and short ranges, is very desirable. Indeed, their power to attain an enemy's column at a long distance obviates, in a measure, proportional to their efficiency, the necessity for using shell-guns, or any other flanking-guns, at close range. The same is true not only of a line or lines of detached field-works located in such defensive relations to each other that the guns of one work flank the faces and sweep the approaches of those adjacent to or in advance of it, but also of continuous lines of intrenchments, with salient points, at intervals armed with artillery to defend the approaches and flank the retired portions. Under these circumstances ranges for flanking-guns of 1,000, 1,200, or even 1,400 yards are not deemed excessive; and the gun that can deliver the most effective fire against troops at these distances must be regarded as the best, other things, including efficiency at short ranges, being equal. If, in addition, this hypothetical gun shall have proved itself capable not only of *delivering* but of *maintaining* uninterruptedly for hours a most destructive fire at all distances, indifferently, from fifty yards up to and beyond a mile, a power conspicuously absent in our present service ordnance, its introduction

into the armament of our fortifications, as an auxiliary, would seem to be an obvious necessity. The Gatling gun is such an arm, and is, beyond question, well adapted to the purposes of flank-defense at both long and short ranges.

3. The 0.42-inch or 0.45-inch caliber Gatling gun can easily fire 400 rounds per minute continuously for hours, with the necessary reliefs at the crank. The 1.00-inch-caliber Gatling gun can fire 155 to 160 shots per minute, but requires more frequent reliefs at the crank than the smaller calibers.

4. Results at 150 yards.

Canvas target 9 feet high by 45 feet wide. Guns on trial: 0.42-inch-caliber Gatling gun; 1.00-inch-caliber Gatling gun; 4.62-inch-caliber bronze gun, 12-pounder Napoleon; 40 Springfield rifles, 0.45-inch caliber.

	Number of shots fired.	Number of hits.
The 0.42-inch-caliber Gatling gun, firing solid shot; time, 1 minute 29½ seconds.	605	594
	Number of balls fired.	Number of hits.
The 12-pounder Napoleon gun, firing six rounds of double special canister, each canister containing twelve lead balls three-quarters of an inch in diameter; time, 1 minute 34 seconds	1,452	601

In this instance the Gatling gun, if the firing had been continued with the same ratio of hits up to one minute thirty-four seconds, (the time occupied in firing six rounds from the Napoleon,) would have put 633 shots through the target; and it would, moreover, have been by far the most effective weapon of the two against troops on account of the greatly superior penetration attained with it, the canister-balls passing through but three thicknesses of one-inch yellow-pine boards, while the shots from the Gatling gun penetrated six thicknesses. The killing and disabling effects of a projectile in a column of troops is, within certain undefined limits, proportional to its penetrating power.

	Number of balls fired.	Number of hits.
The 1.00-inch-caliber Gatling gun, firing canister containing twenty-one lead balls, each ball 0.45 inch diameter and weighing 144 grains; 255 rounds fired; time, 1 minute 29½ seconds	5,355	1,595
40 Springfield rifles, firing 1 minute 30 seconds	614	428

The canister-projectiles here used, although giving a large number of hits in a brief time, are not considered effective, on account of the smallness of the balls and their slight penetration. The maximum penetration for direct hits is scarcely one 1-inch yellow-pine board. It will be seen below that at 200 yards, (a suitable range for canister,) the penetration is less than half an inch. The disabling effects of these projectiles against any kind of troops would be insignificant in comparison with those produced by the solid shot from the 0.42-inch or 0.45-inch caliber Gatling gun, or even by the special-canister from the 12-pounder Napoleon gun, or the 8-inch siege-howitzer, at the same range.

Penetration at 150 yards.

Into 1-inch yellow-pine boards, separated by 1-inch intervals.

	Maximum.	Minimum.	General.
0.42-inch-caliber Gatling gun.....	.....	.....	6 to 7 boards.
1.00-inch-caliber Gatling round canister, 0.45 inch diameter.....	1 board.....	.....	1 board.
12-pounder Napoleon lead canister, 0.75 inch diameter.....	3 boards, full..	2 boards.....	3 boards.
8-inch howitzer canister, 0.75 inch diameter.....	3 boards.....	1 board.....	2 boards.
8-inch howitzer canister, 0.97 inch diameter.....	3 boards, full..	2 boards.....	3 boards.

5. Results at 200 yards.

Canvas target 9 feet high by 45 feet wide. Guns on trial: 0.42-inch-caliber Gatling gun; 1.00-inch-caliber Gatling gun; 4.62-inch bronze gun, 12-pounder, Napoleon; 8-inch siege-howitzer; 40 Springfield rifles, caliber 0.45 inch.

	Number of shots fired.	Number of hits.
0.42-inch-caliber Gatling gun, firing solid shot, (Lowell projectile;) time, 1 minute 29½ seconds; first trial.	637	618
0.42-inch-caliber Gatling gun, firing solid shot, (Lowell projectile;) time, 1 minute 29½ seconds; second trial.	550	530
	Number of slugs fired.	
1.00-inch-caliber Gatling gun, firing canister containing 18 cylindrical slugs, each 0.45 inch diameter by 0.45 inch long and weighing 199 grains; 213 rounds; time, 1 minute 29½ seconds.	3,834	846

	Number of balls fired.	Number of hits.
1.00-inch-caliber Gatling gun, firing canister, (described in the foregoing paragraph;) 230 rounds fired.	4,830	1,172
12-pounder Napoleon, (4.62-inch caliber,) firing double special canister, each containing 121 lead balls, 0.75 inch diameter; number of double rounds, 6; time, 1 minute 35 seconds.	1,452	379
8-inch siege-howitzer, firing single service-canister containing 48 iron balls 1.85 inch diameter; number of rounds fired, 4; time, 1 minute 32½ seconds.	192	52
8-inch siege howitzer, firing single special canister containing 208 lead balls 0.977 inch diameter; number of rounds fired, 4; time, 2 minutes 1½ seconds.	832	312
8-inch siege-howitzer, firing single special canister containing 440 lead balls 0.75 inch diameter; number of rounds fired, 4; time, 1 minute 26½ seconds.	1,760	570
8-inch siege-howitzer, firing double special canister, each containing 440 lead balls 0.75 inch diameter; 4 rounds fired deliberately.	3,532	1,463
40 Springfield rifles, caliber 0.45; time, 1 minute 30 seconds.....	601	320
40 Springfield rifles, fired deliberately in 3 minutes 54¼ seconds	600	436

Penetration at 200 yards into 1-inch yellow-pine boards, separated by 1-inch interval.

	Maximum.	Minimum.	Average.
0.42-inch Gatling gun.....			6 boards = 6 inches.
1.00-inch Gatling gun round canister 0.45-inch diameter ..	0.70 board = 0.70 inch	0.23 board = 0.23 inch	0.45 board = 0.45 inch.
1.00-inch Gatling gun slugs, 0.45 inch diameter.....			Much less than round canister.
12-pounder Napoleon lead canister, 0.75 inch diameter	3 boards.....	2 boards.....	Scant 3 b'ds.
8-inch howitzer lead canister, 0.75 inch diameter	3 boards.....	1 board.....	1½ boards.
8-inch howitzer lead canister, 0.97 inch diameter	3 boards.....	1 board.....	2 boards.

Upon the results of the foregoing competitive trials at ranges of 150 and 200 yards, reference being also had to the diagrams of the targets, it may be remarked as follows, viz:

First. At 150 yards the 12-pounder Napoleon gun, firing double special canister, and the 0.42-inch-caliber Gatling, used with the oscillator so as to cover the target laterally, are about equal in number of hits. The 12-pounder, however, made the best target for want of sufficient dispersion *vertically* in the Gatling.

On the other hand this deficiency is perhaps more than compensated by the superior penetration of the latter.

Second. At both 150 and 200 yards the 1.00-inch-caliber Gatling, firing canister containing either slugs or round balls, cannot be deemed an effective arm, unless the penetration can be increased, for many of the shots would be stopped by the clothing worn by the soldiers, and many others would fail to inflict disabling wounds.

The canister-ammunition used by the board contained only coarse-grained powder adopted for previous trials, when the case was made of thin metal. As the thickness and strength of the case has been greatly increased, a fine-grain quick powder is admissible, and much better results can reasonably be expected from it.

It is the intention of the company to use fine-grained musket powder for all canister-ammunition prepared hereafter for the 1-inch gun.

Third. Forty Springfield rifles, served with average skill, are equal to one 0.42-inch-caliber Gatling gun in the number of shots delivered in a given time; but at 150 yards the latter gave 38 per cent. more hits than the former; and at 200 yards, 79 per cent. more. The forty rifles, however, covered the targets better than the Gatling, and for an equal number of hits would have been more effective against a deep column of troops on account of their greater dispersion vertically.

Reckoned simply by the number of hits in the target, one 0.42-inch-caliber Gatling, using the oscillator, is equal to seventy Springfield rifles firing against time, and fifty-two rifles firing deliberately. Without the oscillator every shot from the Gatling should strike the target.

Fourth. At 200 yards the 8-inch howitzer, firing double special canister, gave more hits than the 0.42-inch-caliber Gatling, used with the oscillator, in the proportion of 1,463 to 574, (average.)

At 200 yards, and probably at 250 yards, one 8-inch howitzer firing this canister would, therefore, be superior in number of hits to two 0.42-inch-caliber Gatling fired with the oscillator; but this superiority, if it exist at all, in delivering disabling hits against troops, is probably restricted to ranges not exceeding 200 yards, bearing in mind the great difference in penetration recorded above. The howitzer covers the target vertically much better than the Gatling.

Fifth. The great inferiority of the 8-inch service-canister containing 48 iron balls is strikingly shown by the record. At 200 yards it gave but

52 hits, as against 312 hits with the largest lead canister, and 570 hits with the smallest; four rounds being fired in each case.

The service-canister for the 24-pounder flank-defense howitzer contains the same number of iron balls (48) as the 8-inch service-canister; but as the balls are much smaller in the former than in the latter, being, indeed, only a little more than one-third as heavy, their range, penetration, and general effectiveness would be proportionally less; giving for 4 rounds at 200 yards probably not more than 25 or 30 disabling hits.

But if filled with lead balls, 0.75 inch diameter, the 24-pounder howitzer canister, retaining the prescribed weight of the finished projectile, would contain about 170, and would doubtless be quite as effective, in proportion to the number of lead balls fired, as the special 8-inch canister, delivering, in four single rounds at 200 yards, upwards of 200 disabling hits in a target of the dimensions used.*

Results at 500 yards.

Canvas target 9 feet high by 45 feet wide. Guns on trial: 0.42-inch-caliber Gatling gun; 4.62-inch-caliber bronze gun, 12-pounder Napoleon; 8-inch siege-howitzer.

	No. of shots fired.	No. of hits.
0.42-inch-caliber Gatling gun, firing solid shot; time, 1 minute 30 seconds....	600	557
12-pounder Napoleon with time-fuse, firing spherical-case containing 82 lead balls 0.69-inch diameter; 7 rounds fired; time, 1 minute 30 seconds.	574 lead balls.	55
12-pounder Napoleon, 6 rounds fired; time, 1 minute 30 seconds.	492 lead balls.	184
8-inch siege howitzer with time-fuse, firing spherical-case containing 486 lead balls 0.69 inch diameter; 4 rounds fired; time, 1 minute 30 seconds.	1944 lead balls.	112
RESULTS AT 800 YARDS.		
<i>Same target and same guns as at 500 yards.</i>		
0.42-inch-caliber Gatling gun, firing solid shot, deliberately, (aim unknowingly too high.)	600	106
0.42-inch-caliber Gatling gun, firing solid shot, deliberately.....	600	534
12-pounder Napoleon gun with time-fuse and spherical-case, as above; 7 rounds, fired deliberately.	574 lead balls.	3
12-pounder Napoleon gun with time-fuse and spherical-case, as above; 7 rounds, fired deliberately.	574 lead balls.	35
8-inch siege howitzer with time-fuse and spherical-case, as at 500 yards; 4 rounds, fired deliberately.	1944 lead balls.	0

* A number of explosive bullets were fired from the 1-inch Gatling gun into the penetration target, at a distance of 200 yards. They usually penetrated three or four boards, and then burst, splintering the target considerably. The shattering effect, however, appeared to be greatly diminished by the intervals between the boards, and would doubtless have been much greater in solid wood.

This record shows in a striking manner the vast superiority of the Gatling gun against troops at ranges beyond effective reach of canister, or say beyond 250 yards, for the projectiles in competition with it, whether case-shot or shell, are subject to a variety of disadvantageous conditions, more or less beyond control, among which may be enumerated the inaccuracy common to smooth-bore guns; the varying effects of the wind, due to changes in either force or direction, or to both; the eccentricity of the projectiles, and the imperfection of fuses, the latter having been, during the trials of the board, a conspicuous and fruitful cause of the very poor results obtained.

At 500 yards 1 Gatling, fired with oscillator, gave 58 per cent. more hits than 2 12-pounder Napoleons and 1 8-inch howitzer together, each firing 1 minute 30 seconds.

At 800 yards the proportions of hits were very largely increased in favor of the Gatling, there being an average of 320 hits for 1 Gatling against an aggregate of only 38 hits for 2 Napoleons and 1 howitzer.

Some of the shells did not explode at all, while others burst either too soon or too late to be effective.

In some cases the fuse blew out without bursting the shell. There were only a few bad line-shots, and it was not considered that the pieces were unskillfully served. Neither was the wind unusually high while firing with shell and case-shot. Indeed, no abnormal condition prevailed in any marked degree, and the failure to achieve good results was due directly to characteristic defects in the kind of ammunition used, not under certain and uniform control of existing knowledge or skill on this subject. The ammunition had been prepared with great care by Major Baylor, and in average excellence was not regarded as inferior in quality.

Results at 1,000 to 1,150 yards.

Targets representing a column of infantry. Guns on trial: 0.42-inch-caliber Gatling gun; 4.50-inch-caliber siege-rifle; 8-inch siege-howitzer.

The firing at ranges from 1,000 to 1,150 yards was made at a series of targets representing a regiment of infantry in a column of companies, at full distance, approaching or retiring from the battery, the nearest company being 1,000 yards and the farthest 1,150 yards distant from the gun.

The targets were made of 1-inch yellow-pine boards; were each 6 feet high and 50 feet wide, and placed one behind the other 50 feet apart.

The diagrams of targets and the target-records show the number and location of hits in each target.

Only the aggregate number of hits in the entire column is given below for each piece. Time assumed to be the same for each; it having been ascertained by trial that the 8-inch howitzer and 4½-inch rifle could each fire 4 rounds while the Gatling gun was firing 600 shots.

	No. of shots fired.	No. of hits.
0.42-inch-caliber Gatling gun	600	526
0.42-inch-caliber Gatling gun	600	691
4.50-inch rifle, shrapnel, 4 rounds	672	334
4.50-inch rifle, shrapnel, 4 rounds	672	164
8-inch siege-howitzer, spherical-case No. 2 containing 470 lead balls, 14 to the pound, 4 rounds.	1880	615
8-inch siege-howitzer, spherical-case No. 2 containing 470 lead balls, 14 to the pound, 4 rounds.	1880	407

In these trials the same causes already noticed operated to prevent good results with the case-shot. Some did not burst at all; some passed the column of targets before bursting; several fell short, and a few had so great a lateral deviation as to be lost.

With a time-fuse that, at 1,000 to 1,200 yards, would burn uniformly to within half a second of the time to which it is cut, the 8-inch howitzer ought to give many more hits in a column of targets like those used than the small Gatling gun. The percussion-fuses, used with the shrapnel from the 4½-inch rifle, proved to be equally unreliable. As a rule, they cannot be depended upon, after making a reasonable allowance for contingencies, to explode when the projectile strikes; and this uncertainty, taken in connection with the erratic flight of some projectiles, which were entirely lost, and the meager results due to the want of desired precision in others, renders their aggregate effectiveness variable and capricious.

In the column of targets the Gatling gun gave 17 per cent. more hits than the 8-inch howitzer and 144 per cent. more than the 4½-inch rifle.

In the trials at Shoeburyness, reported the 28th of November, 1871; the same difficulty was encountered. In referring to it the committee remark as follows: "Looking to the uncertainty of shell-fire, even with the best percussion or time-fuses, there can be little doubt that a body of troops

having to advance to the attack of an intrenched position, *over any distance within 1,200 yards*, would suffer far more from Gatling guns delivering an incessant and widespread fire of the deadliest mitraille than from field-guns."

Results at 1,200 yards.

Target 9 feet high by 45 feet wide. At 1,200 yards the only gun tried by the board was the 0.42-inch Gatling. Two trials were made, firing deliberately without the oscillator.

	Number of shots fired.	Number of hits.
First trial	600	180
Second trial	600	413

The oscillator not having been used the target was not well covered by the shots in either case, the lateral dispersion on the first trial being 27 feet and on the second 30 feet. With an oscillator covering a sector of 3 degrees, as now arranged, the lateral dispersion at 1,200 yards would be 188 feet, assuming the projectiles to fly in the vertical plane of sight, and the number of hits would not have exceeded one-fifth to one-fourth of those really obtained.

A sector of 1 degree embraces a target 62 feet wide 1,200 yards distant.

Although the advantages, for target-practice, where the hits cannot be seen even with a glass, of an automatic oscillator adjustable at pleasure for any sector from zero to 10 or 12 degrees are plainly obvious, it does not follow that such a mechanism is equally necessary under all circumstances, when operating against troops, for the reason that in the latter case the points reached by the projectiles (unless the firing is very bad) and the effects produced can generally be observed from the gun, and the direction and elevation of the piece adjusted and varied, from time to time, as circumstances require. But in order to leave as little as possible to the judgment of the enlisted men, by whom in actual service the gun will be served, and thereby secure the best results, an adjustable automatic oscillator is considered desirable.

Recapitulation of trials by the board, arranged according to distances of target from the gun.

Number of trial.	Kind of gun.	Range in yards.	Projectile.	Fuse.	Elevation.	Number of rounds fired.	Number of projectiles thrown.	Number of hits.	Time of firing.		Remarks.
									M.	S.	
1	12-pdr Napoleon gun...	150	Double special canister, each containing 121 lead balls 0.75 inch in diameter and 11 to the pound.	.....	0 30	6	1,452	601	1	34	
2	40 Springfield rifles.....	150	Single solid shot.....	.....	.....	614	614	428	1	30	Brisk wind from left to right.
3	Gatling gun, cal. 1 in ..	150	Canister, each containing 21 lead balls 0.45 inch in diameter.	.....	.....	255	5,355	1,595	1	29½	Upright cases used.
4	Gatling gun, cal. 0.42 in.	150	Single solid shot...	.....	.....	605	605	594	1	29½	Upright cases used.
5	8-inch siege-howitzer...	200	Single special canister, each containing 208 lead balls 0.977 inch in diameter.	.....	1 00	4	832	312	2	15	In this trial the men waited for the command to fire to be given.
6	8-inch siege-howitzer...	200	Service-canister, each containing 48 iron balls 1.85 inch in diameter.	.....	1 00	4	192	52	1	32½	Firing as rapidly as possible.
7	8-inch siege-howitzer...	200	Single special canister, each containing 440 lead balls 0.75 inch in diameter.	.....	1 30	4	1,760	570	1	26½	Firing as rapidly as possible.
8	12-pdr Napoleon gun...	200	Double special canister, each containing 121 lead balls 0.75 inch in diameter.	.....	1 45	6	1,452	379	1	35	Firing as rapidly as possible.
9	8-inch siege-howitzer...	200	Double special canister, each containing 440 lead balls 0.75 inch in diameter.	.....	1 30	2	1,760	718	.....	.....	Target too much shattered to complete the four rounds contemplated.
10	8-inch siege-howitzer...	200	Double special canister, each containing 440 lead balls 0.75 inch in diameter.	.....	1 30	4	3,520	1,463	Deliberately.	.....	Brisk wind across line of fire from left to right.
11	Gatling gun, cal. 0.42 in.	200	Single solid shot.....	.....	.....	637	637	618	1	29½	Feed-drum used.
12	Gatling gun, cal. 0.42 in.	200	Two ball-cartridges.	.....	.....	272	544	414	1	29½	One case clogged and delayed firing.
13	Gatling gun, cal. 0.42 in.	200	Single solid shot....	.....	.....	550	550	530	1	29½	Upright cases used.
14	Gatling gun, cal. 1 in...	200	Canister containing 18 cylindrical slugs.	.....	0 30	213	3,834	846	1	29½	Upright cases used.
15	Gatling gun, cal. 1 in...	200	Canister containing 21 round balls.	.....	0 30	230	4,830	1,172	1	29½	Upright cases used.
16	40 Springfield rifles....	200	Single solid shot.....	.....	.....	601	601	320	1	30	Brisk wind from left to right.

Recapitulation of trials by the board—Continued.

Number of trial.	Kind of guns.	Range in yards.	Projectile.	Fuse.	Elevation.	Number of rounds fired.	Number of projectiles thrown.	Number of hits.	Time of firing.	Remarks.
				Secs.	° ' "				M. S.	
17	40 Springfield rifles	200	Single solid shot....	.....	.....	15 ea.	600	436	Deliberately.	Brisk breeze from left to right.
18	12-pdr Napoleon gun...	500	Spherical case.....	1½	1 15	6	492	184	1 30	Fourth round did not burst; fifth round burst beyond target.
19	12-pdr Napoleon gun...	500	Spherical case.....	1½	1 15	7	574	55	1 31	
20	8-inch siege-howitzer...	500	Spherical case.....	1½, 2, 2, 2½	2, 2 30, 3, 4	4	1,944	112	Deliberately.	
21	Gatling gun, cal. 0.42 in.	500	Single solid shot....	.....	.....	600	600	557	..do...	
22	12-pdr Napoleon gun...	800	Spherical case.....	2, 3, 3, 3, 3, 3, 3	2 00	7	.....	3	..do...	All except the last shot burst beyond the target.
23	12-pdr Napoleon gun...	800	Spherical case.....	2½, 2½, 2½, 2, 2, 2, 2	2 00	7	.....	35	1 30	Two did not burst and three burst beyond the target.
24	8-inch siege-howitzer...	800	Spherical case.....	3½	6½ 00	4	.....	.....	Deliberately.	All failed to explode.
25	Gatling gun, cal. 0.42 in.	800	Single solid shot....	.....	.....	600	600	106	..do...	Aim too high and to left.
26	Gatling gun, cal. 0.42 in.	800	Single solid shot....	.....	.....	600	600	534	..do...	Brisk breeze across line of fire.
27	Gatling gun, cal. 0.42 in.	1,200	Single solid shot....	.....	.....	600	600	180	..do...	
28	Gatling gun, cal. 0.42 in.	1,200	Single solid shot....	.....	.....	600	600	413	..do...	
29	4½-in. rifled gun	1,000 to 1st targ.	Shrapnel	Schenkl perc'n.	2 50	4	672	334	1 30	One shell did not burst.
30	4½-inch rifled gun.....	1,000 to 1st targ.	Shrapnel	Schenkl perc'n.	2 45	4	672	164	Deliberately.	One burst beyond target.
31	8-inch siege-howitzer...	1,000 to 1st targ.	Spherical case.....	4½	6 10	4	1,880	615	..do...	One lost to right of target.
32	8-inch siege-howitzer...	1,000 to 1st targ.	Spherical case.....	4½	6 10	4	1,880	407	..do...	But one shell burst in column.
33	Gatling gun, cal. 0.42 in.	1,000 to 1st targ.	Single solid shot....	.....	2 00	600	600	526	..do...	Aim too low.
34	Gatling gun, cal. 0.42 in.	1,000 to 1st targ.	Single solid shot....	.....	2½ 00	600	600	691	..do...	In the last six trials ten targets 6 feet by 50 feet, of 1-inch yellow-pine boards, representing a column of ten companies at full distance, the nearest being 1,000 yards from gun. In all the others a canvas target 45 feet by 9 feet was employed.

Comparative effect of the 0.42-inch Gatling gun, and other guns placed in competition with it by the board, showing the weight of ammunition expended, and the number of hits scored in a given time, viz, 1 minute 30 seconds :

Range in yards.	8-inch siege howitzer.		12-pounder Napoleon gun.		0.42-inch Gatling gun.		40 Spring-field rifles.		4½-inch rifle.		Remarks.
	Weight of ammunition in pounds.	Number of hits.	Weight of ammunition in pounds.	Number of hits.	Weight of ammunition in pounds.	Number of hits.	Weight of ammunition in pounds.	Number of hits.	Weight of ammunition in pounds.	Number of hits.	
150.....			186	601	91	594	60	428			Firing single special canister of lead balls 5 to the pound. Firing single service-canister. Firing single special canister of lead balls 11 to the pound. 8-inch howitzer and 12-pounder, firing double special canister of lead balls 11 to the pound.
200.....	232	312									
200.....	230	52									
200.....	232	570									
200.....	448	1,463	186	379	86	574	58	320			At ten targets, 50 by 6 feet, representing a column of 10 companies at full distance; nearest company 1,000 yards from gun.
500.....	254	112	112	120	88	557					
800.....	254		120	19	88	320					
1,000.....	265	511			88	609			140	249	
Total	1,915	2,981	604	1,119	441	2,654	118	748	140	249	
Average in given time..	274	426	151	280	88	531	59	374	140	249	

Comparative effect of the 0.42-inch Gatling gun and the other guns placed in competition with it, calculated from the foregoing table for a constant weight of ammunition, viz, 297 pounds, being the weight of ammunition carried in the limber-box of the Gatling gun, 0.42-inch caliber :

Range in yards.	Weight of ammunition.	Number of hits for 8-inch howitzer.	Number of hits for 12-pounder Napoleon gun.	Number of hits for Gatling gun.	Number of hits for Springfield rifles.	Number of hits for 4½-inch rifle.	Remarks.
150.....	297		960	1,939	2,119		12-pounder, firing double special canister of lead balls 11 to the pound.
200.....	297	399					Single special canister of lead balls 5 to the pound.
200.....	297	730					Single special canister of lead balls 11 to the pound.
200.....	297	67					Single service-canister.
200.....	297	970	605	1,982	1,639		8-inch howitzer and 12-pounder, firing double special canister of lead balls 11 to the pound.
500.....	297	131	318	1,880			8-inch howitzer and 12-pounder, firing spherical case.
800.....	297		47	1,080			Do. Do. Do.
1,000.....	297	573		2,055		528	At ten targets, 50 feet by 6 feet, representing a column of companies at full distance; the nearest company being 1,000 yards from gun. 8-inch howitzer and 4½ inch rifle, firing case-shot.
Total	2,376	2,870	1,930	8,936	3,758	528	
Average.....	297	410	492	1,787	1,879	528	

Views and recommendations of the board.

I. Among the advantages possessed by the Gatling gun may be enumerated the lightness of its parts, the simplicity and strength of its mechanism, the rapidity and continuity of its fire without sensible recoil, its effectiveness against troops at all ranges for which a flanking-gun is required, its general accuracy at all ranges attainable by rifles, its comparative independence of the excitement of battle, the interchangeableness of its ammunition with the same caliber of small-arms, and its great endurance.

II. Its disadvantages, compared with howitzers and other shell-guns, are, its inability to deliver a curved fire so as to reach an enemy behind intervening obstacles, or to search his rifle-pits and covered ways; its want of effectiveness against troops covered by even the slightest entrenchments, or lodged in villages and houses, or in heavy woods; and generally its entire deficiency in breaching-power.

III. In permanent fortifications, where the lines of defense do not exceed two hundred yards, and therefore very generally in our permanent works, nothing would be gained by using the Gatling 0.42-inch gun for flanking purposes instead of the 8-inch howitzer, firing the special canister devised by the board. In special cases, where the flanking-guns can fire over the counterscarp and command the approaches for a considerable distance, the Gatling gun, being good at both long and short ranges, could be advantageously introduced as an auxiliary.

IV. For the defense of detached field-fortifications, placed in defensive relations to each other, and entrenched positions with long lines of defense, the Gatling gun would be superior to any other species of artillery against troops exposed to view, and therefore a most valuable auxiliary to shell-guns.

V. One advantage possessed by the Gatling gun is its lightness, and hence the ease with which it can be withdrawn from position, when exposed to breaching-batteries or any overpowering or disabling fire, and replaced in battery to meet the critical moment of an assault.

VI. The board recommend the adoption of the Gatling gun as an auxiliary arm for flanking purposes, but not to any very considerable displacement of shell-guns, in any locality or under any circumstances. The caliber of the Gatling gun adopted should be the same as that of the serv-

ice small-arm, so that the ammunition will be interchangeable between the two.

VII. The 1-inch caliber Gatling gun possesses no special advantages for flanking purposes. In rapidity of fire it is greatly inferior to the smaller calibers, and this inferiority is not compensated by the greater weight and longer range of the 1-inch solid shot, while the 1-inch canister projectiles, whether filled with spherical balls or cylindrical slugs, cannot, with the penetrations obtained by the board, be considered an effective missile against troops at one hundred and fifty to two hundred yards, while beyond two hundred yards it would be comparatively harmless. With quicker powder, it would doubtless give better results.

VIII. The service-canister for the 8-inch siege-howitzer is manifestly very much inferior to the special canister used by the board. This remark, of course, applies equally to other calibers. It is therefore recommended that the use of round cast-iron balls for canister be discontinued, and that lead balls not lighter than 11 to the pound be substituted therefor. Balls 8 to the pound would perhaps be still better. But for the use of this special canister the 0.42-inch Gatling gun would in all cases have given the best results in the competitive trials had before the board.

IX. Although the board is not prepared to state to what precise extent the Gatling gun should be introduced into that portion of the armament of fortifications intended, either specially or contingently, to be used for flanking purposes, the proportion of one Gatling gun for one shell-gun is suggested. It is believed the number of Gatlings ought not to exceed the number of shell-guns.

X. It is further suggested that the Gatling Gun Company be requested to devise and manufacture for trial two casemate-carriages for their 0.45-inch gun, to be placed side by side in one flank-casemate, the carriages to be so arranged, if practicable, that the centers of motion for elevating and depressing the piece, as well as for changes in the direction of fire, shall be at the throat of the embrasure; also that the company be requested to devise an improvement in the oscillator, as suggested in the remarks under the head of "Results at 1,200 yards."

XI. The board have necessarily limited the scope of their recommendations to the restricted field of inquiry contemplated in the order, and have therefore not touched upon the most prominent advantages claimed

and generally conceded for the Gatling gun. Among these may be enumerated its peculiar power for the defense of intrenched positions and villages; for protecting roads, defiles, and bridges; for covering the embarkation or debarkation of troops, or the crossing of streams; for silencing field-batteries or batteries of position; for increasing the infantry-fire at the critical moment of a battle; for supporting field-batteries and protecting them against cavalry or infantry charges; for covering the retreat of a repulsed column; and generally the accuracy, continuity, and intensity of its fire, and its economy in men for serving and animals for transporting it.

It is suggested that the relations which this gun shall occupy to the different arms of service should be prescribed by competent authority.

Respectfully submitted.

Q. A. GILLMORE.

Maj. Engineers, Bvt. Maj. Gen.

T. J. TREADWELL,

Maj. Ordnance.

L. LORAIN,

Capt. Third Artillery.

NEW YORK, *January 16, 1874.*

ORDNANCE OFFICE, *January 21, 1874.*

The foregoing report is respectfully submitted to the Secretary of War with the following recommendations:

1st. The adoption of the Gatling gun, caliber 0.45, using the service-cartridge, as an auxiliary arm for flank-defense of fortifications.

2d. The adoption of a special canister for 8-inch flank-defense howitzer, to contain lead balls.

3d. The designing and manufacturing of two casemate-carriages for the Gatling gun, as suggested by the board.

4th. The adoption of the Gatling gun, caliber 0.45, as an auxiliary arm for all branches of the service.

5th. The appointment of a board of engineer and ordnance officers to determine on the proportionate number of such guns in fortifications for flank-defense, and the whole number required on July 1, 1874.

6th. The relations it shall occupy to the different arms of service, and the number to be held in reserve for that purpose, should be settled by competent authority.

By order of the Chief of Ordnance.

S. V. BENÉT, *Major of Ordnance.*

Respectfully referred to the Chief of Engineers for remarks.

By order of the Secretary of War.

H. T. CROSBY, *Chief Clerk.*

JANUARY 22, 1874.

OFFICE OF THE CHIEF OF ENGINEERS,
Washington, January 23, 1874.

Respectfully referred to the Board of Engineers for Fortifications for report.

By command of—

Brig. Gen. HUMPHREYS.

THOMAS LINCOLN CASEY,
Major of Engineers.

OFFICE BOARD OF ENGINEERS FOR FORTIFICATIONS,
New York, February 3, 1874.

Respectfully returned to the Chief of Engineers, with report of board of this date.

J. G. BARNARD,
Col. of Eng. and Bvt. Maj. Gen.,
Prest. Board of Eng. for Fortifications.

OFFICE OF BOARD OF ENGINEERS FOR FORTIFICATIONS,
Army Building, New York, February 3, 1874.

GENERAL :

The Board of Engineers for Fortifications having examined the report referred to them by your indorsement of January 23, 1874, of a special board of officers upon the introduction of the Gatling gun for flank-defense in fortifications, have the honor to submit the following views thereon. The

experimental firings with the Gatling gun compared with those of the 8-inch howitzer and 24-pounder Napoleon are clearly set forth and fully discussed by the officers conducting these firings, and this board concur generally in their deductions and conclusions. While a good flank-defense of most of our forts may not require the introduction of the Gatling gun, its use as an auxiliary in special cases may be desirable.

The fire of canister, 440 bullets at once, has the effect of a volley, and the first discharge may completely break an assaulting column. This volley effect of the howitzer is in part made up by the continuity of fire of the Gatling, and the combination of the two, the latter filling up the intervals between the volleys, would seem to be superior to either singly, unless the number of howitzers gives a rapidity of fire approaching continuity.

The Gatling requires fewer gunners for its service, and there are some small works where the garrisons may be quite limited on the breaking out of war necessitating economy of men in the service of the pieces. These guns on the ramparts in such works, would supply the place of a large number of soldiers. In many of our works the strength is superabundant, and either system of flank-defense will doubtless be sufficient. Before determining to what extent the Gatling may be introduced as an auxiliary, it will be necessary to take up our permanent works *seriatim* and discuss the probabilities and nature of the attack, and decide therefrom if any change in the flank-guns will be required. From their position and strength many forts will need no change. In the more exposed works, especially in the cases noted by the board, the Gatling will doubtless aid flank-defense.

2d. This board give it as their opinion that a number of Gatling guns may be effectually used on the parapet of works, as being more accurate in their fire at a distance upon reconnoitering parties, both by land and water, than field-artillery, or pieces in position, or even musketry, and they can be served with less exposure. Many of the barbette-batteries that have been recommended by this board are isolated and unsupported by permanent works. Some small keeps will probably be built to protect them. The Gatling gun will be found very efficient in these keeps to clear the advanced batteries if attacked by boat or shore parties with a view to spiking the guns, and will sweep the approaches to such batteries. Further, the Gatling gun will prove very serviceable in firing into the embrasures of iron-clad ships that approach within 1,000 or 1,200 yards of a fort. For these various purposes it will be perceived that each fort may use judiciously a num-

ber of Gatling guns, and their utility may be further developed when once introduced into service. The study of each fortified position should be made before determining, even in a general manner, the number of such guns needed.

Though concurring generally in the deductions of the special board as to the utility of the Gatling gun in many positions, a thorough discussion of our forts may show, as before stated, that only a limited portion of them will need the auxiliary assistance of the Gatling gun for an efficient flank-defense. Its efficiency in field-works, not only for flank but for direct fire, seems unquestionable.

The report of the board on Gatling guns, with letter of transmittal, are herewith returned, (in separate package, by mail.)

Respectfully submitted.

J. G. BARNARD,

Col. of Eng. and Bvt. Maj. Gen.

Z. B. TOWER,

Lieut. Col. of Eng. and Bvt. Maj. Gen.

H. G. WRIGHT,

Lieut. Col. of Eng. and Bvt. Maj. Gen.

Brig. Gen. A. A. HUMPHREYS,

Chief of Engineers, U. S. A., Washington, D. C.

Fifth indorsement.

OFFICE OF THE CHIEF OF ENGINEERS,

Washington, February 6, 1874.

Respectfully returned to the War Department, with report of the Board of Engineers for Fortifications upon the matter of the use of Gatling guns, and report of board on Gatling guns. The views and suggestions contained in the report of the board of engineers are approved.

A. A. HUMPHREYS,

Brig. Gen. and Chief of Engineers.

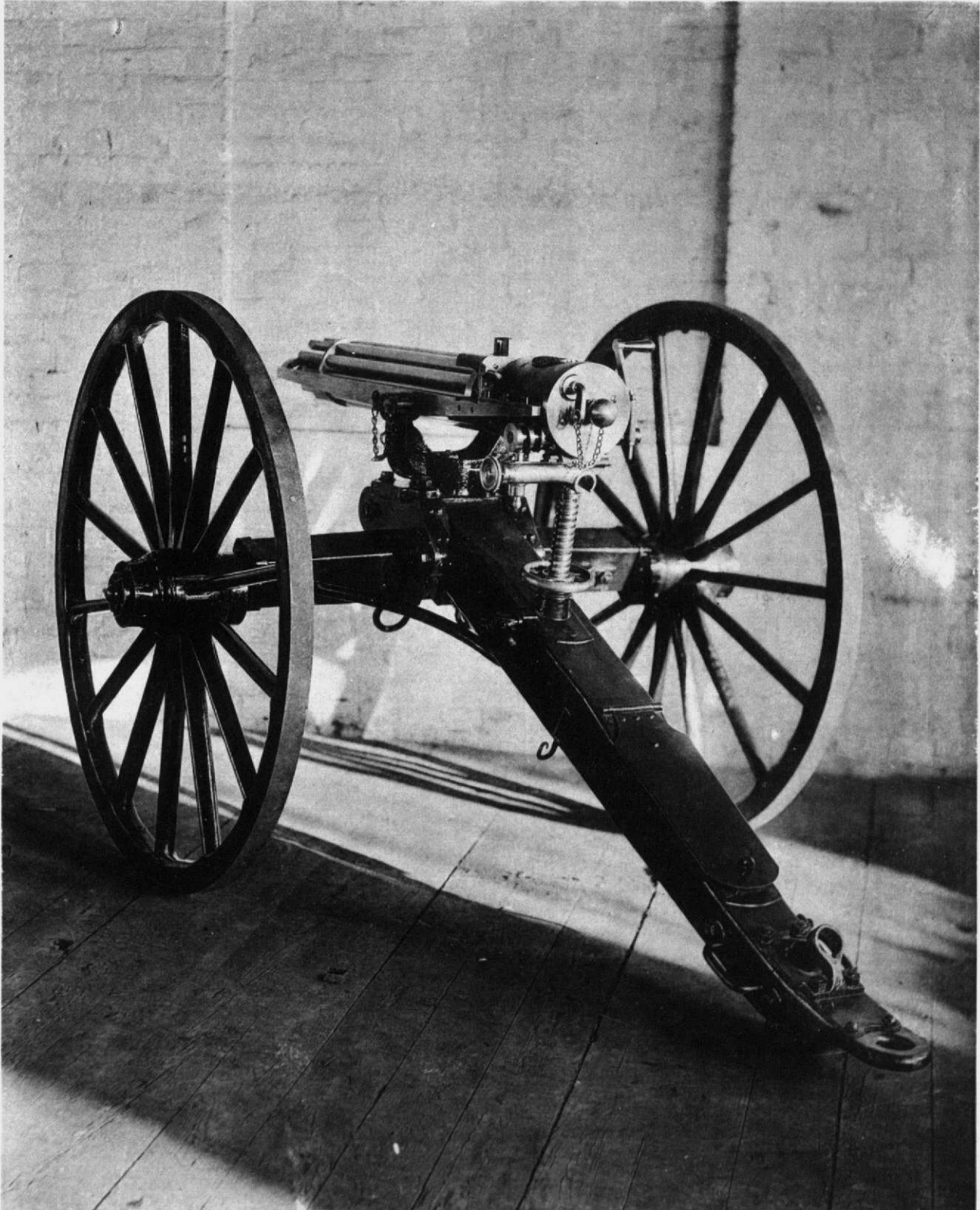
The recommendations of the Chief of Ordnance are approved.

By order of the Secretary of War.

H. T. CROSBY, *Chief Clerk.*

FEBRUARY 11, 1874.

Fig. 1.



GATLING GUN , CALIBRE 0.42 INCH
DEVELOPEMENT OF THE SPIRAL CAM AND FIRING MECHANISM
SHOWING ALSO THE ACTION OF THE LOCKS RELATIVELY TO THE BARRELS.

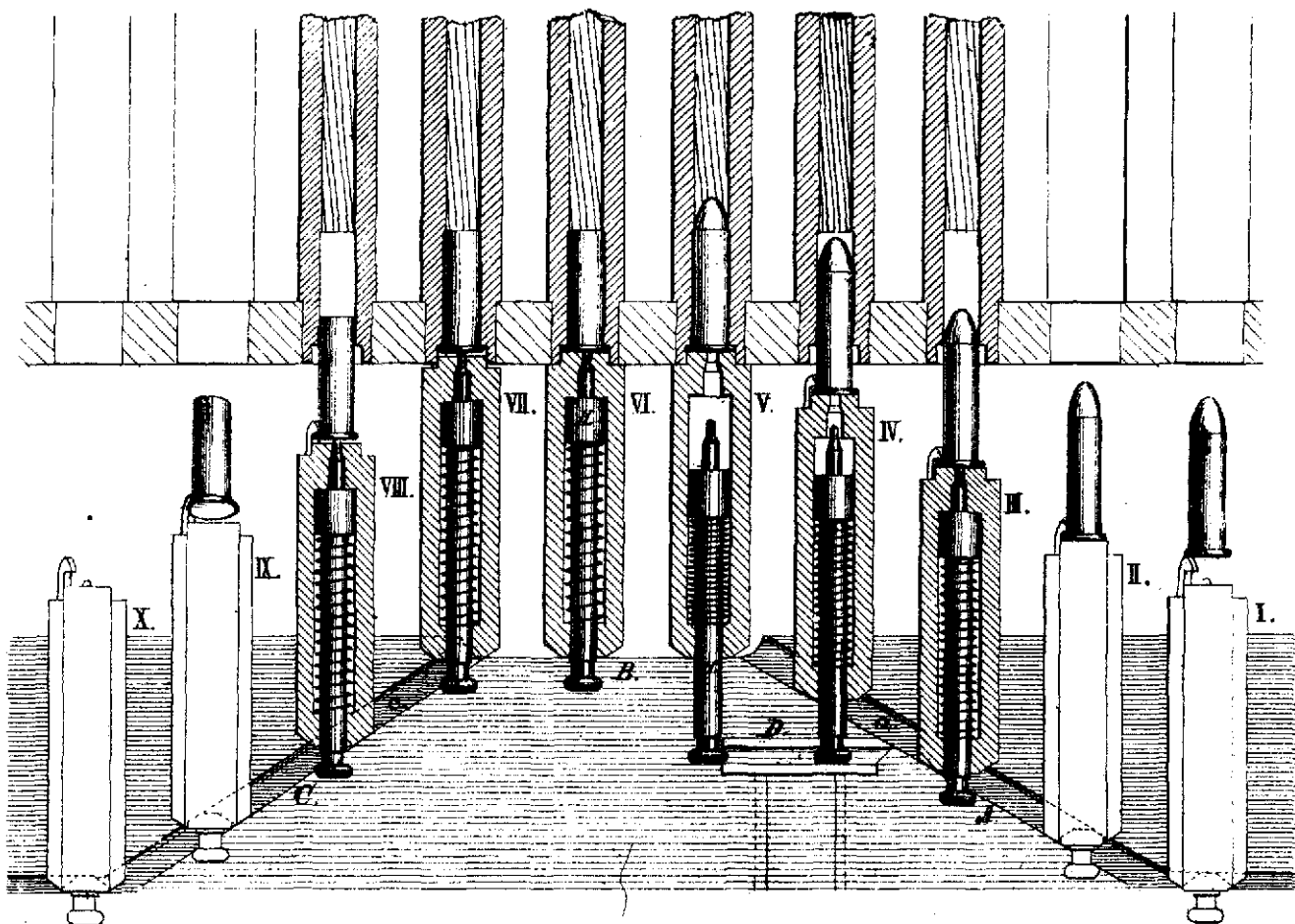


Fig. 2.

Fig. 3.

Fig. 4.

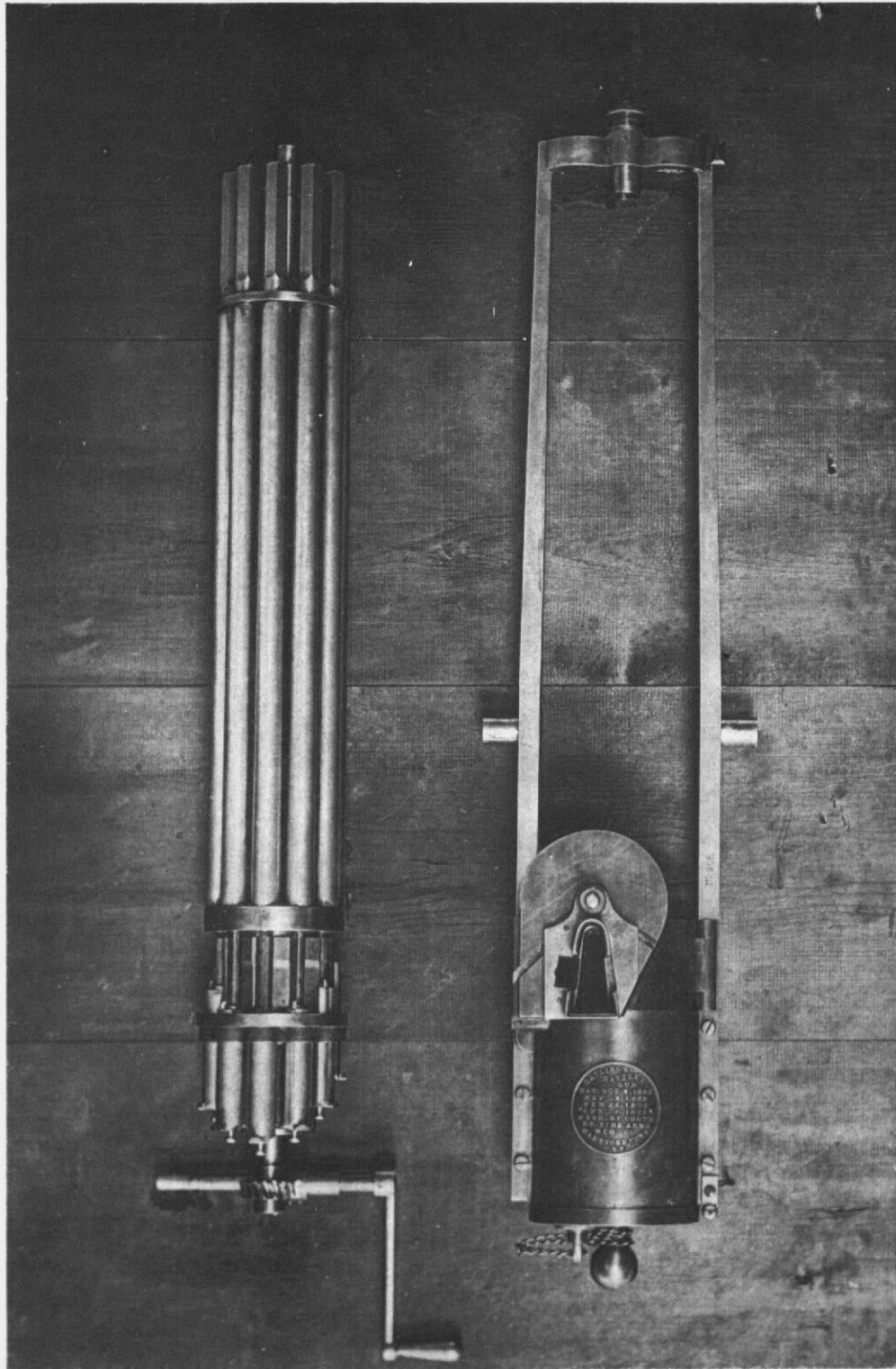


Fig. 5.

FEED-CASE FOR 45 INCH GATLING GUN.

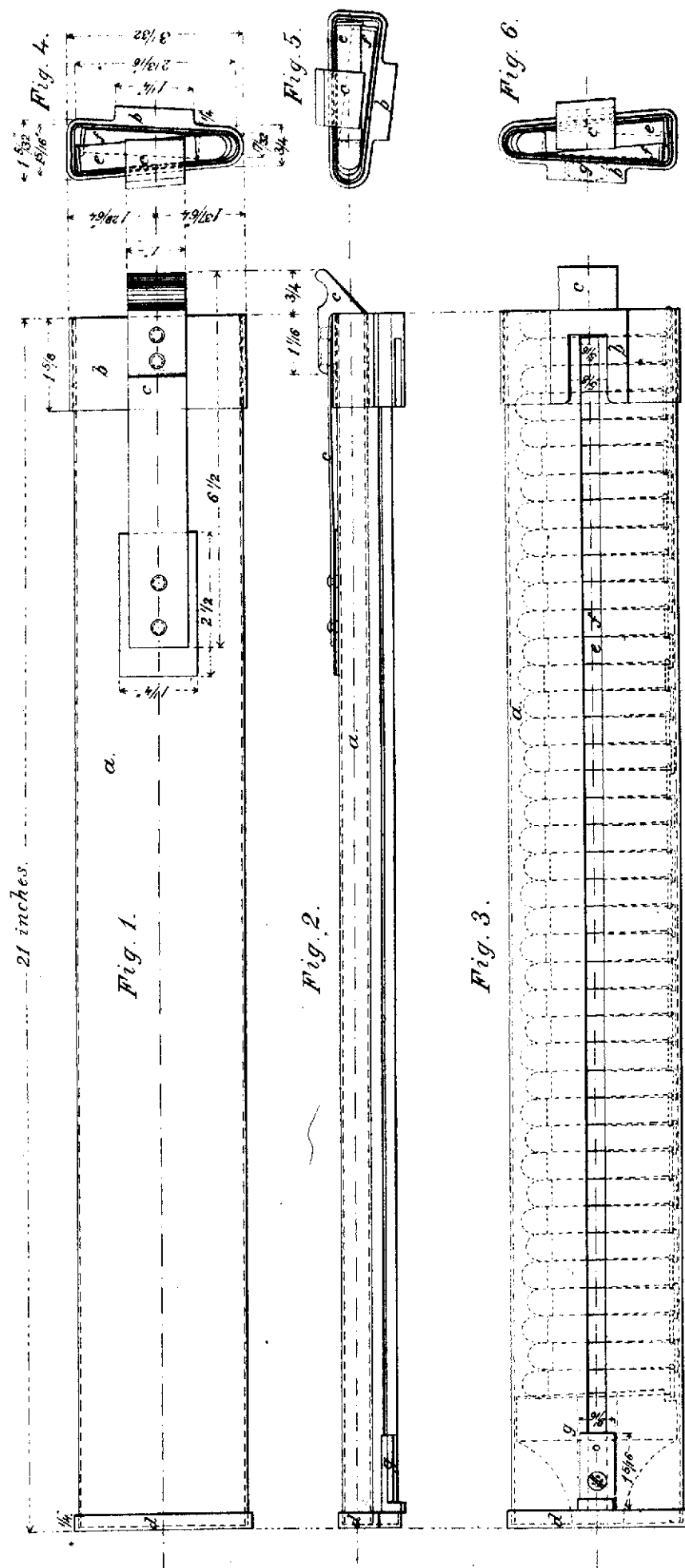


Fig. 1, Side-view, right.

Fig. 2, Front-view.

a, Tin case
b, Bottom band

Fig. 3, Side-view, left.

Figs. 4, 5, 6, Bottom-view.

c, Spring catch.
d, Top cap.
e & f, 40 cartridges.
g, Weight.

AMMUNITION USED

WITH THE GATLING 1 INCH & 0.42 INCH CALIBRES.

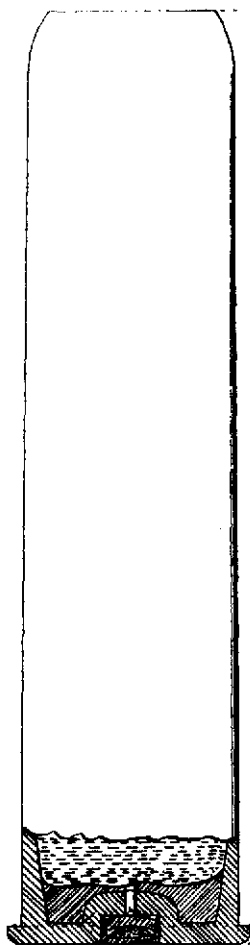


FIG. 7.

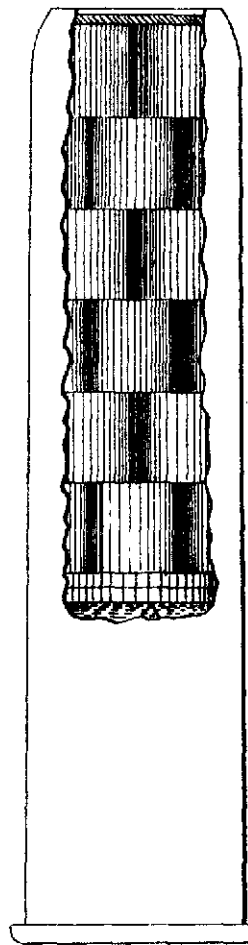
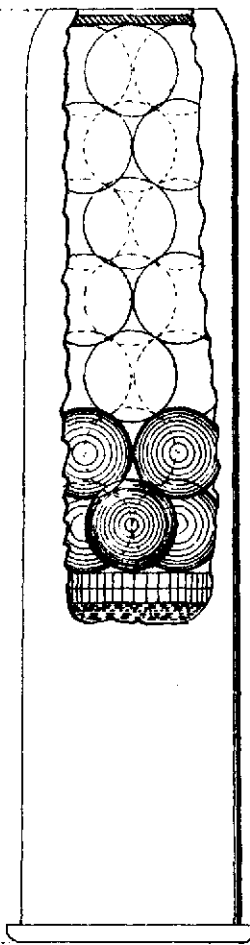


FIG. 8.

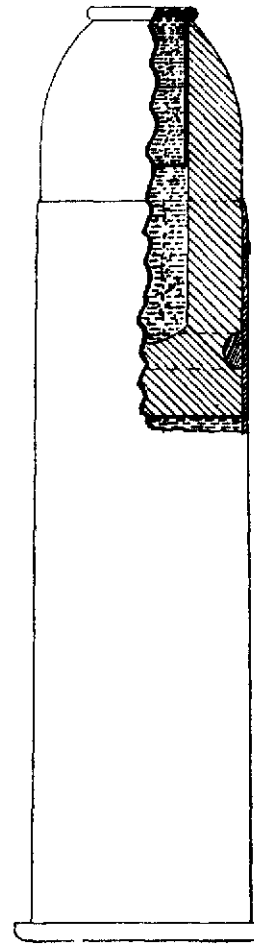


FIG. 9.

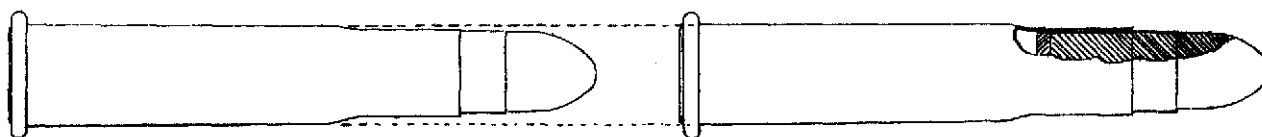
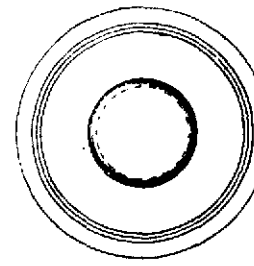
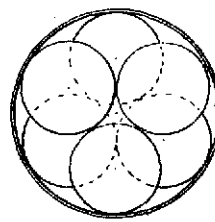
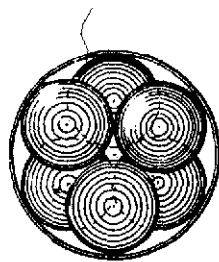
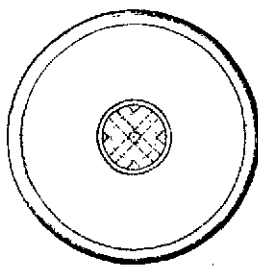


FIG. 6.

TRIAL No. 1.

12 pdr. Napoleon gun of 4.62 in. calibre.

Distance, 150 yds.

Target, canvas 9 feet by 45 feet.

*Projectile, double canister, each canister containing 121 lead balls
of 0.751 in. diam. and 0.091 lbs. in weight.*

Total weight of one canister 14.5 lbs.

Charge, 2 lbs.

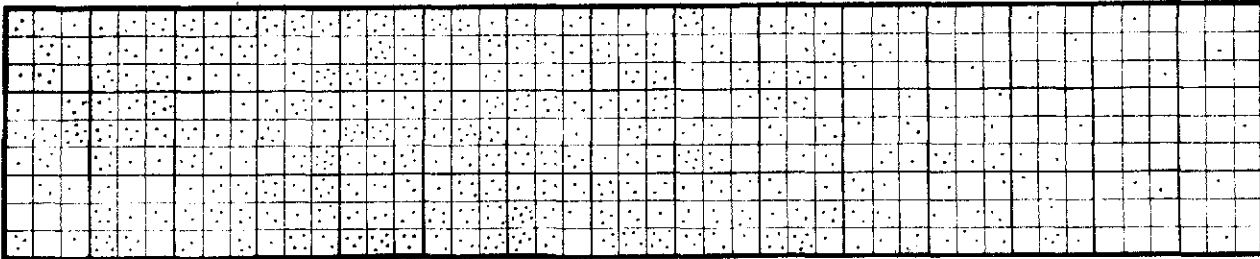
Elevation, 0°30'.

No. of rounds fired, 6, in 1'34."

No. of balls fired, 1452.

No. of hits 601.

— This projectile was special canister prepared for these trials.



TRIAL No. 2.

Forty men with Springfield Rifles.

Distance, 200 yds.

Target, canvas 9 feet by 45 feet.

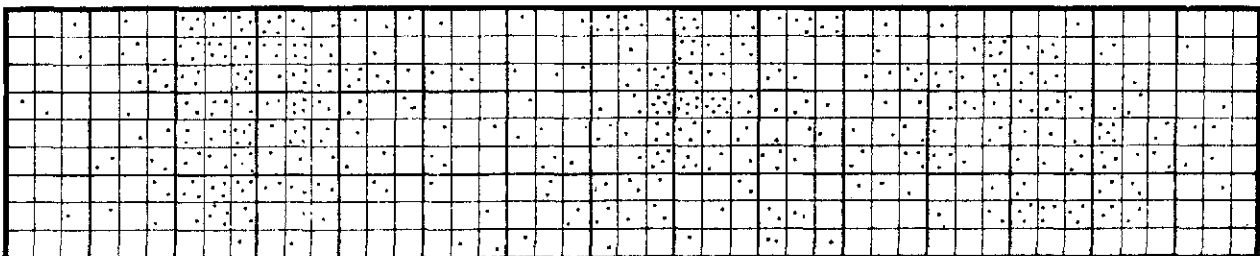
Firing service ammunition

No. of rounds fired, 614.

No. of hits, 428.

Time, 1'30."

Wind brisk from left to right.



TRIAL No. 3.

Gatling 10 barrel gun of 1.00 in. cal.

Distance, 150 yds.

Canvas target, 9 ft. by 45 ft.

Firing canister with 21 round lead balls from upright feed cases.

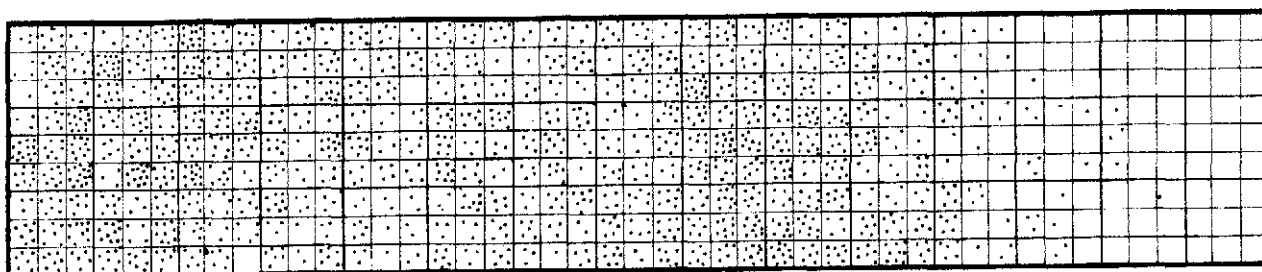
Weight of each projectile, 4922 grains.

Weight of each ball, 144 grains.

Time, 1'29"5.

No. of canister fired, 255 = 5355 balls.

No. of hits, 1595.



TRIAL No. 4.

Gatling 10 barrel gun of 0.42 in. cal.

Distance, 150 yds.

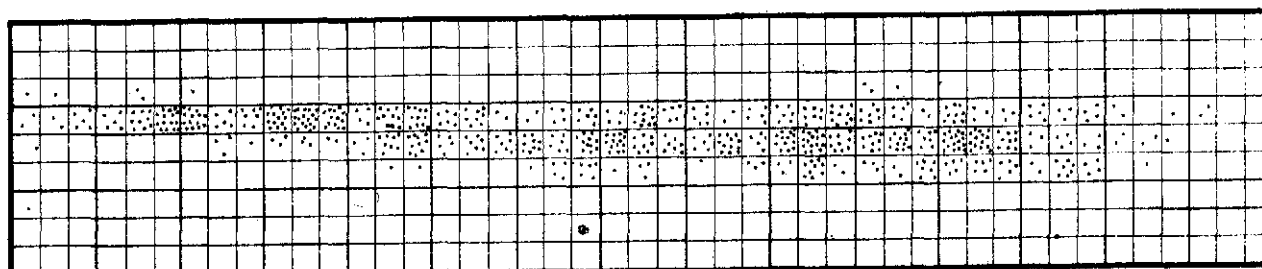
Canvas target, 9 ft. by 45 ft.

Firing single solid shot with upright cases.

Time, 1'29"5.

No. of shots fired, 605.

No. of hits, 594.



TRIAL No. 5.

8 in. Siege Howitzer.

Distance, 200 yds.

Canvas target, 9 ft. by 45 ft.

Firing single special canister containing 208 lead balls of 0.977 in. diam. and 0.2 lbs. in weight. Total weight of one canister 54 lbs.

Charge, 4 lbs.

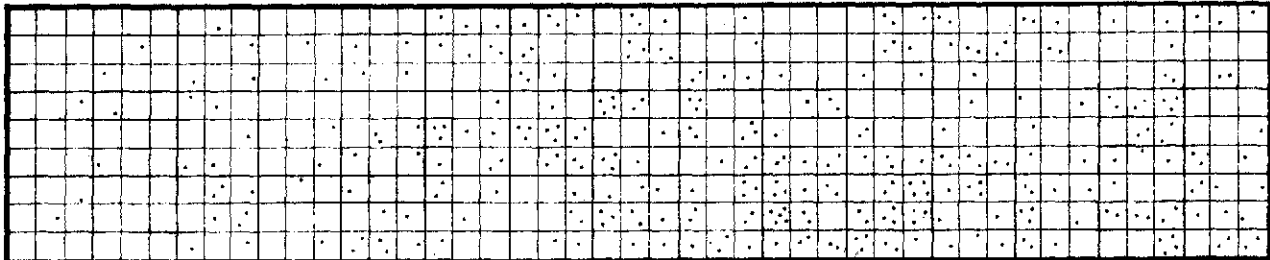
Elevation, 1°

Four rounds fired, in 2'1".5

Hits, 312.

Wind dead ahead 18 to 20 miles per hr.

— The excess in time of firing in this trial over the succeeding ones is due to waiting for the command to fire which was omitted in the latter.



TRIAL No. 6.

8 in. Siege Howitzer.

Distance, 200 yds.

Canvas target, 9 ft. by 45 ft.

Firing single service canister containing 48 iron balls of 1.85 in. dia. and 0.86 lbs. in weight. Total weight of one canister 53.5 lbs.

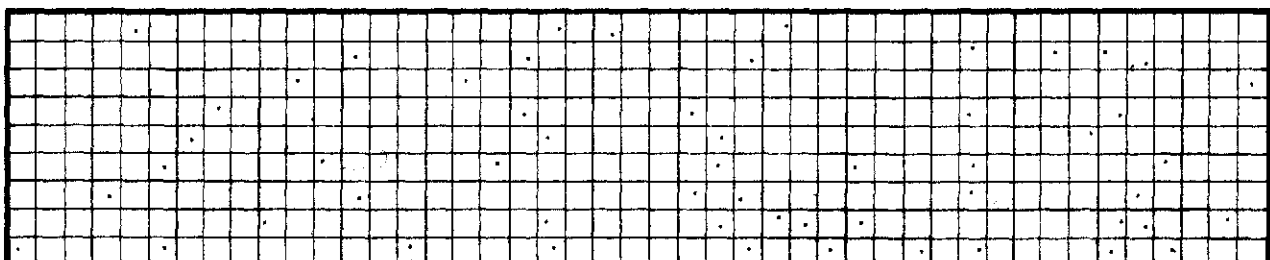
Charge, 4 lbs.

Elevation, 1°

Four rounds fired in 1'32".5

Hits, 52.

Wind dead ahead 18 to 20 miles per hr.



TRIAL No. 7.

8 in. Siege Howitzer.

Distance, 200 yds.

Canvas target, 9 ft. by 45 ft.

Firing single special canister containing 440 lead balls of 0.75 in. diam. and 0.091 lbs. in weight. Total weight of canister 54 lbs.

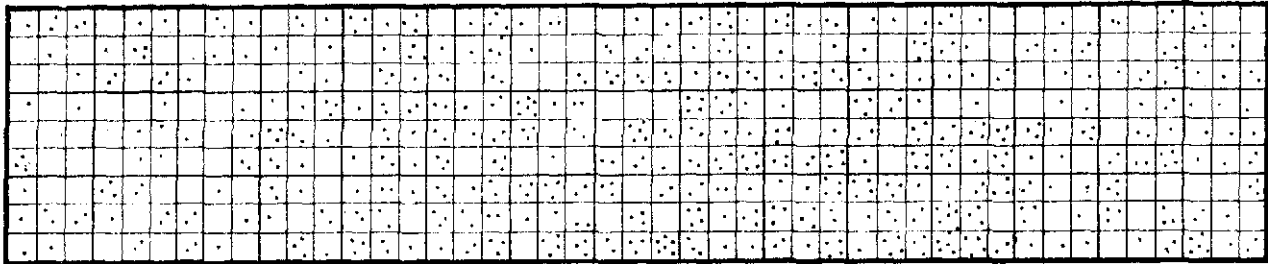
Charge, 4 lbs.

Elevation, 1°30'.

Four rounds fired, in 1'26".5.

No. of hits, 570.

Wind dead ahead 10 to 12 miles per hr.



TRIAL No. 8.

12 pdr. Napoleon gun of 4.62 in. cal.

Distance, 200 yds

Canvas target, 9 ft. by 45 ft.

Firing double canister, each containing 121 lead balls of 0.75 in. diam. and 0.091 lbs. in weight. Total weight of one canister 14.5 lbs.

Charge, 2 lbs.

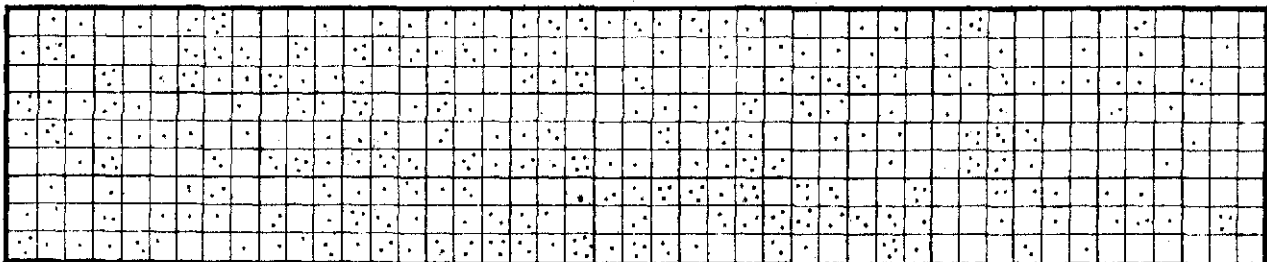
Elevation, 1°45'.

Six rounds fired, in 1'35."

No. of balls fired = $2 \times 6 \times 121 = 1452$.

No. of hits, 379.

— This projectile was special canister prepared for these trials.



TRIAL No. 9.

8 in. Siege Howitzer.

Distance, 200 yds.

Canvas target, 9 ft. by 45 ft.

Firing double special canister, each canister containing 440 lead balls of 0.751 in. diam. or 11 to the lb. Total weight of one canister 54 lbs.

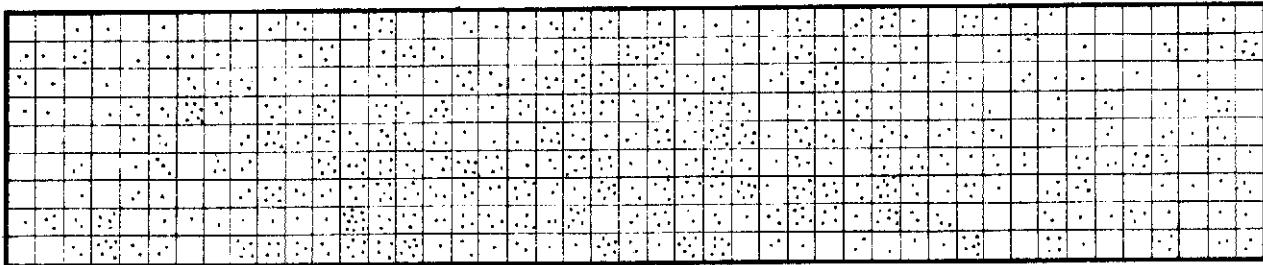
Charge, 4 lbs.

Elevation, 1°30'.

Two rounds fired deliberately containing $2 \times 2 \times 440 = 1760$ balls.

No. of hits, 718, counted after each round.

— The intention was to fire four rounds of double canister but the target was too much shattered to be used for more than two.



TRIAL No. 10.

8 in. Siege Howitzer.

Distance, 200 yds.

Canvas target, 9 ft. by 45 ft.

Firing double special canister, each canister containing 440 lead balls of 0.751 in. diam. or 11 to the lb.

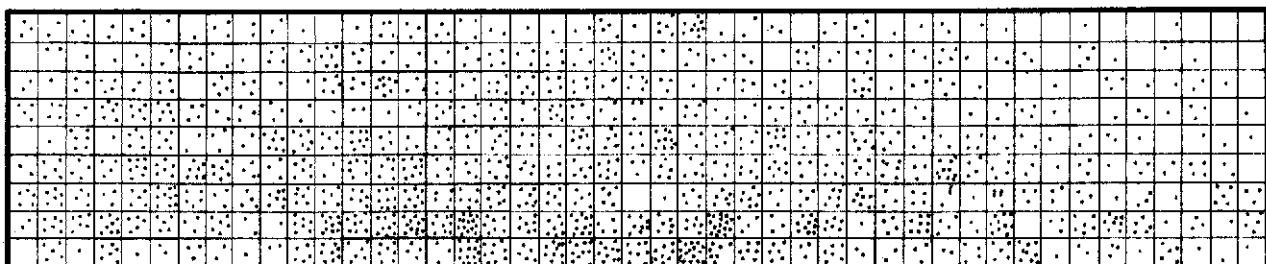
Elevation, 1°30'.

Four rounds fired deliberately.

No. of balls fired, 3520

No. of hits, 1463.

Wind brisk from left to right across line of fire.



TRIAL No. 11.

Gatling 10 barrel gun of 0.42 in. cal.

Distance, 200 yds.

Canvas target, 9 ft. by 45 ft.

Firing single solid shot with feed drum.

Time, 1'29"5.

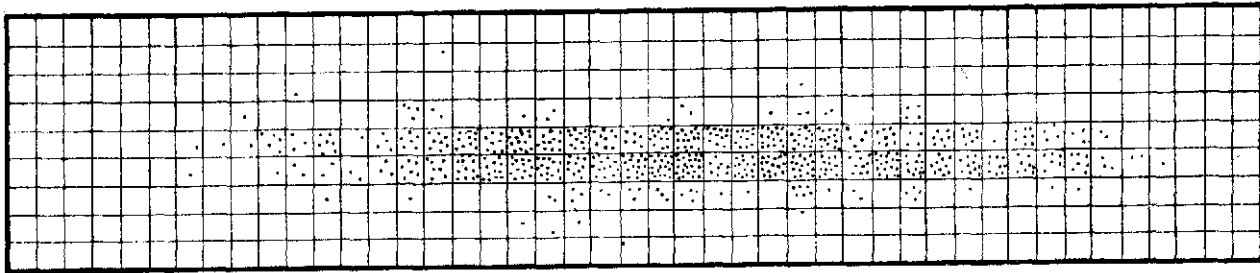
No. of shots fired, 637.

No. of hits, 618.

— One man turned the crank for first drum relieved by another for the second drum.

The time taken was the average time required to fire four rounds with the 8 in. howitzer as determined by trials 6 and 7.

Wind dead ahead 10 to 12 miles per hr.



TRIAL No. 12.

Gatling 10 barrel gun of 0.42 in. cal.

Distance, 200 yds.

Canvas target, 9 ft. by 45 ft.

Firing two ball cartridges.

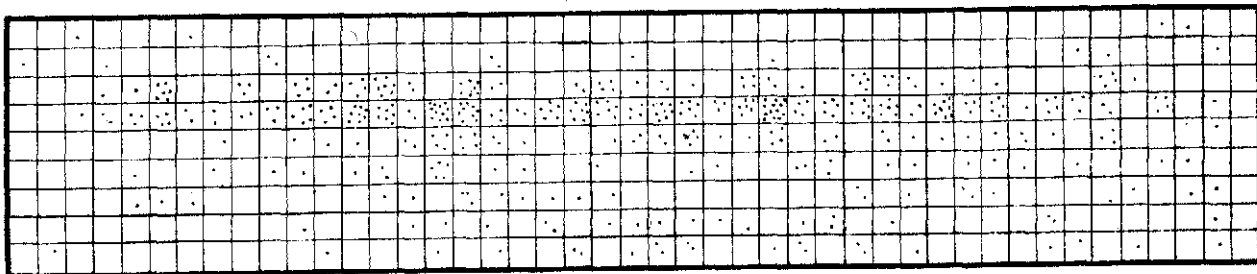
Time, 1'29"5.

No. of rounds fired, 272 = 544 balls.

No. of hits, 414.

— The projectile contained one pointed & one cylindrical ball.

The drum was used. — Man at crank relieved once.



TRIAL No. 13.

Gatling 10 barrel gun of 0.42 in. cal.

Distance, 200 yds.

Canvas target 9 ft. by 45 ft.

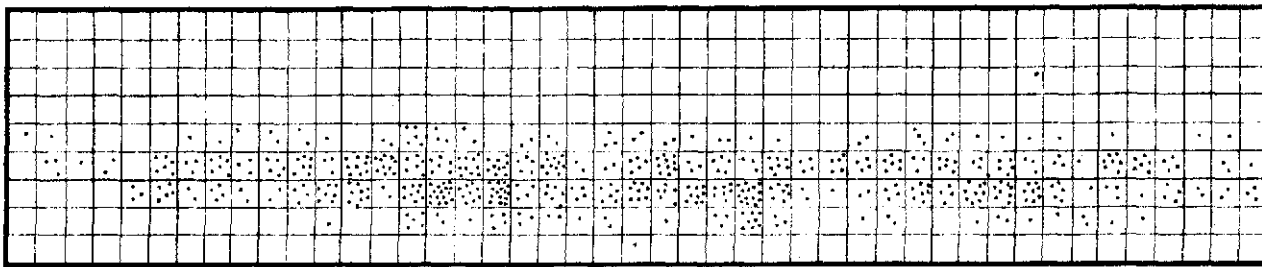
Firing single solid shot with upright cases.

Charge, 77 grains.

Time of firing, 1'29"5.

No. of shots fired, 550.

No. of hits, 530.



TRIAL No. 14.

Gatling 10 barrel gun of 1.00 in. cal.

Distance, 200 yds.

Canvas target, 9 ft. by 45 ft.

Firing canister with 18 cylindrical slugs from upright feed cases.

Weight of projectile, 5543 grs., of slug 199 grs., length 0.45 in., diam. 0.45 in.

Elevation, 0°30'.

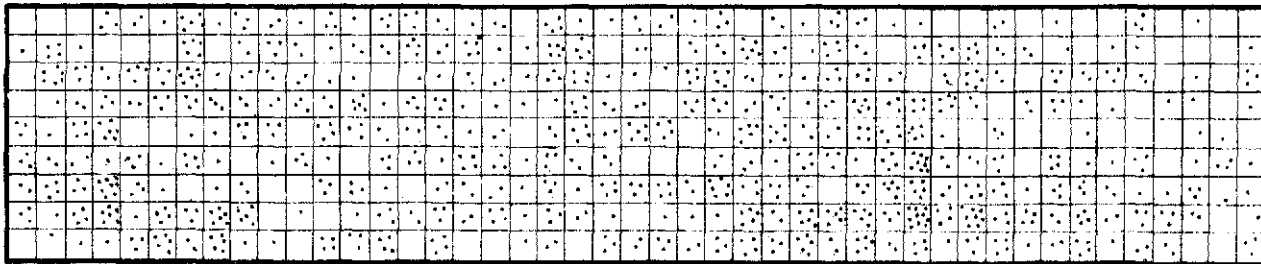
Time, 1'29"5.

Charge, $\frac{3}{4}$ of an oz.

No. of canisters fired, 213 = to 3834 slugs.

No. of hits, 846.

— Man. at crank relieved once during firing.



TRIAL No. 15.

Gatling 10 barrel gun of 1.00 in. cal.

Distance , 200 yds .

Canvas target , 9 ft. by 45 ft.

Firing canister with 21 round lead balls from upright feed cases.

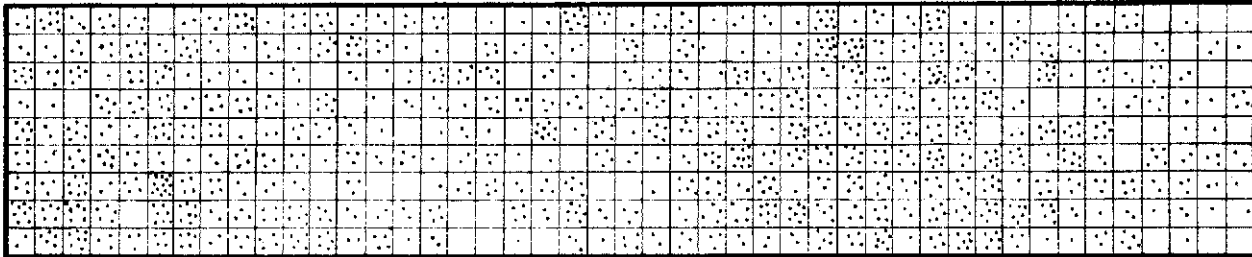
Weight of projectile , 4922 grains. Lead balls 0.45 in. diam. and 144 grains in weight.

Time , 1' 29" 5.

Charge , $\frac{3}{4}$ of an oz.

No. of canisters fired , 230 = 4830 balls .

No. of hits , 1172 .



TRIAL No. 16.

Forty men with Springfield Rifles.

Distance , 200 yds.

Canvas target , 9 ft. by 45 ft.

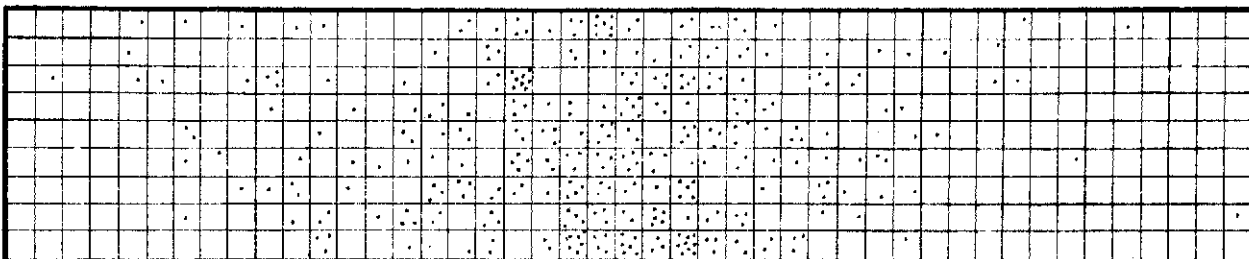
Firing service ammunition.

No. of rounds fired , 601.

No. of hits , 320 .

Time , 1' 30" .

Wind brisk from left to right.



TRIAL No. 17.

Forty men with Springfield Rifles.

Distance, 200 yds.

Canvas target, 9 ft. by 45 ft.

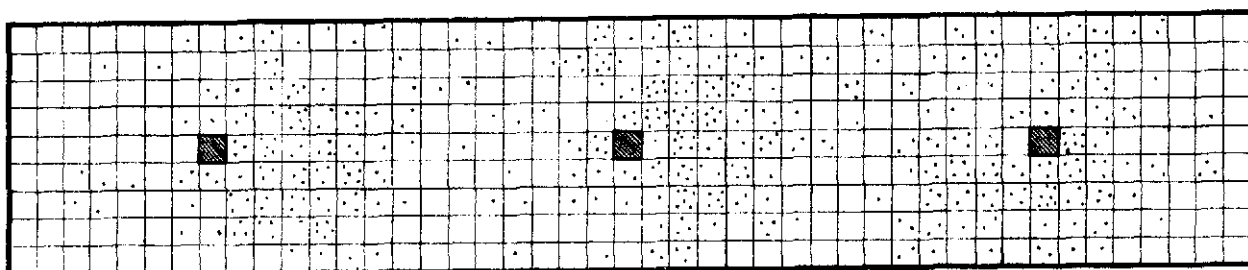
Firing service ammunition deliberately.

No. of rounds fired, 600.

No. of hits, 436.

Time, 3' 54 1/4".

Wind brisk from left to right.



TRIAL No. 18.

12 pdr. Napoleon gun of 4.62 in. cal.

Distance, 500 yds.

Canvas target, 9 ft. by 45 ft.

Firing spher. case. Each shell containing 82 lead balls of 0.69 in. dia. and 0.071 lbs. weight. Total weight of case shot (fixed) 14.7 lbs.

Charge, 2.5 lbs.

Elevation, 1° 15'.

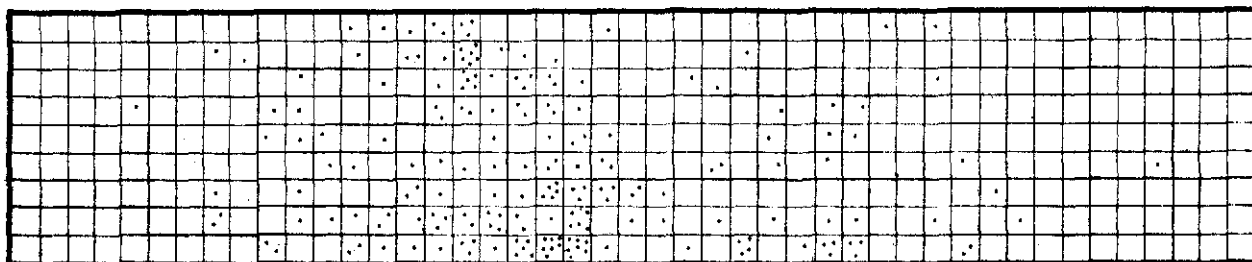
Six rounds fired deliberately.

No. of balls fired, 492.

No. of hits, 184.

Bormann fuze cut to 1"5

— 1st, 2nd, & 3rd, rounds burst in 1"75 about 100 ft. in front. — 4th, round did not explode (lost). — 5th, round burst 15 ft. beyond target (lost). — 6th, round burst in 1"5, 60 ft. in front.



TRIAL No. 19.

12 pdr. Napoleon gun of 4.62 in. cal.

Distance , 500 yds.

Canvas target , 9 ft. by 45 ft.

*Firing spherical case shot. Each shell containing 82 lead balls of
0.69 in. diam. & 0.071 lbs. weight. Total weight of one case shot (fixed) 14.7 lbs.*

Charge , 2.5 lbs.

Elevation , 1°15'.

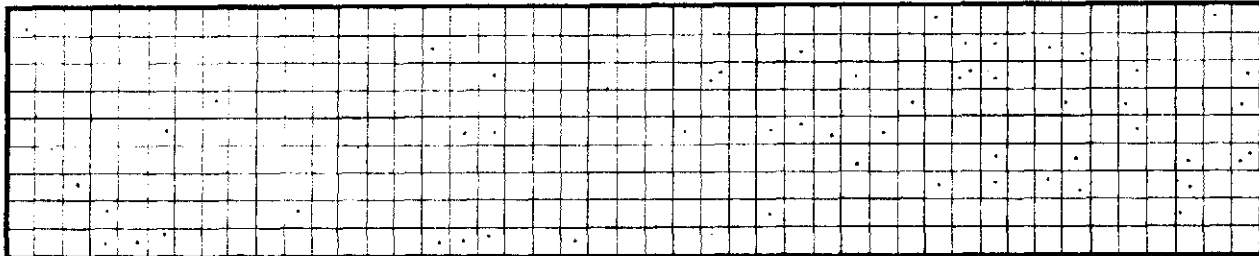
Seven rounds fired in 1'31"

No. of balls fired, $82 \times 7 = 574$.

No. of hits , 55.

Bormann fuze cut to 1"5.

1st. round burst beyond target. — None were good line shots.



TRIAL No. 20.

8 in. Siege Howitzer.

Distance , 500 yds.

•Canvas target , 9 ft. by 45 ft.

*Firing spherical case shot. Each shell containing 486 lead balls of
.0.69 in. diam. & 0.071 lbs. weight. Total weight of one case shot 59.5 lbs.*

Charge , 4 lbs.

Four rounds fired deliberately.

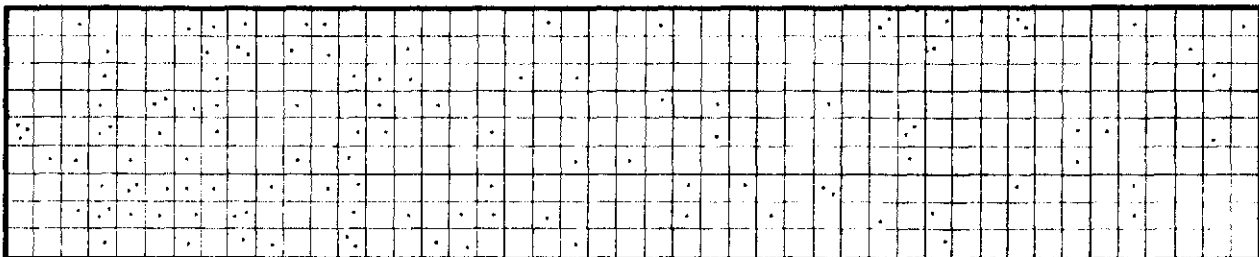
Necessary time 1'26"5, as before determined.

No. of balls fired , 1944.

No. of hits , 112.

1st. round, Elev. 2°, Fuze 1"75, burst 200 ft. short. 3rd. round, Elev. 3°, Fuze 2", burst 250 ft. short.

2nd. ,, ,, 2°30' ,, 2" ,, 200,, ,, 4th. ,, ,, 4° ,, 2"5 ,, 175,, ,,



TRIAL No. 21.

Gatling 10 barrel gun of 0.42 in. cal.

Distance, 500 yds.

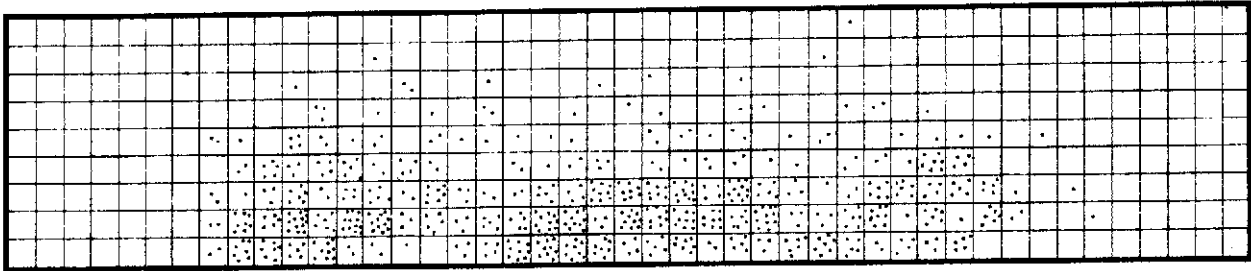
Canvas target, 9 ft. by 45 ft.

Firing single solid shot in upright cases deliberately.

40 balls in each case.

No. of shots fired, 600.

No. of hits, 557.



TRIAL No. 23.

12 pdr. Napoleon gun of 4.62 in. cal.

Distance, 800 yds.

Canvas target, 9 ft. by 45 ft.

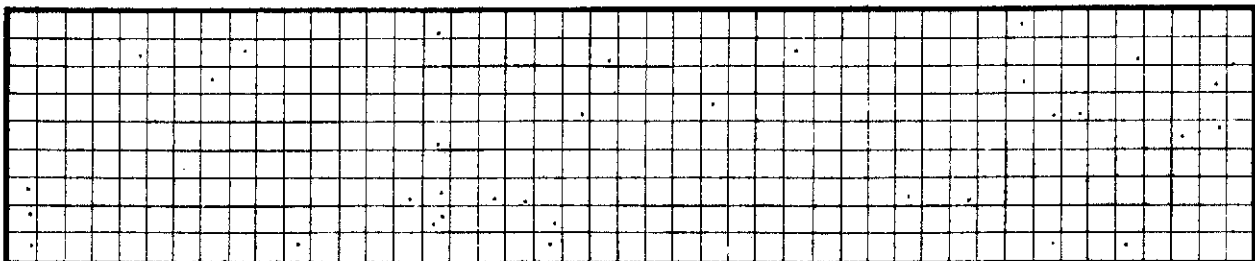
Firing spherical case shot.

Seven rounds fired in 1'30."

Elevation, 2°.

For three rounds the fuze was cut to 2 $\frac{1}{4}$, and for the other four to 2"—Two did not burst, and three burst beyond target.

No. of hits, 35.



TRIAL No. 25.

Gatling 10 barrel gun of 0.42 in. cal.

Distance, 800 yds.

Canvas target 9 ft. by 45 ft.

Firing single solid shot in upright cases deliberately.

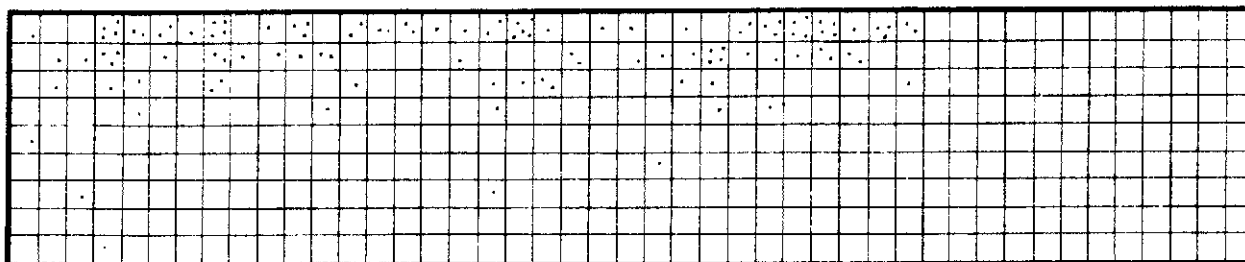
40 balls in each case.

No trial shot made before firing

No. of shots fired, 600.

No. of hits, 106.

Strong 15 knot breeze across line of fire.



TRIAL No. 26.

Gatling 10 barrel gun of 0.42 in. cal.

Distance, 800 yds.

Canvas target, 9 ft. by 45 ft.

Firing single solid shot in upright cases.

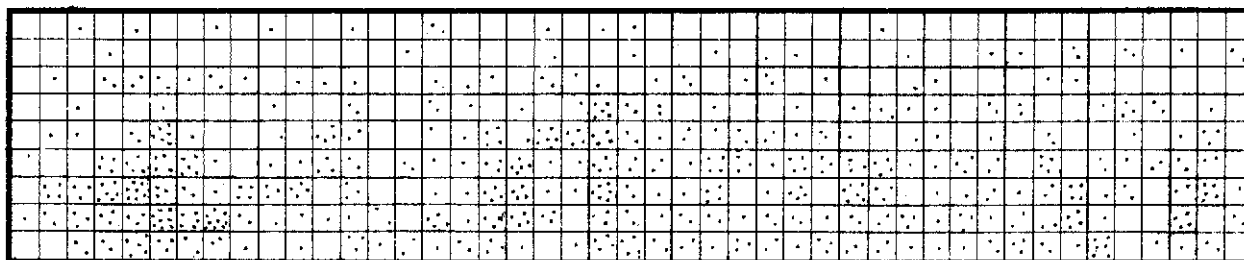
40 balls in each case.

Forty trial rounds fired to get range.

No. of shots fired, 600.

No. of hits, 534.

Brisk breeze across line of fire.



TRIAL No. 27.

Gatling 10 barrel gun of 0.42 in. cal.

Distance, 1200 yds.

Canvas target, 9 ft. by 45 ft.

Firing single solid shot with upright cases.

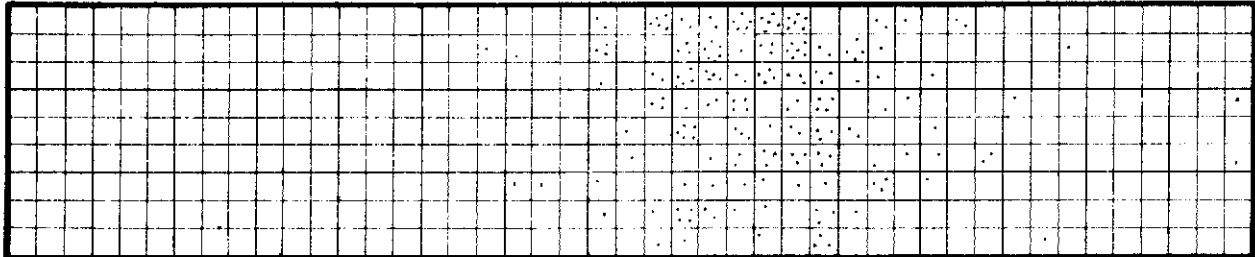
Oscillator not used.

Gun aimed at centre of target.

No. of shots fired deliberately, 600.

No. of hits, 180.

Wind fresh from rear to front.



TRIAL No. 28.

Gatling 10 barrel gun of 0.42 in. cal.

Distance, 1200 yds.

Canvas target, 9 ft. by 45 ft.

Firing single solid shot with upright cases.

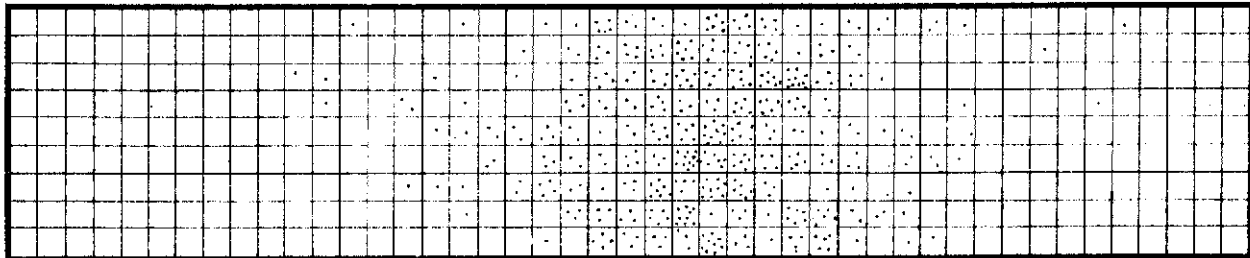
Oscillator not used.

Gun aimed at centre of target.

No. of shots fired deliberately, 600.

No. of hits, 413.

Wind fresh from rear to front.



TRIAL No. 29.

4½ in. Rifled Siege Gun.

*Column of ten board targets, each 6 feet by 50 feet,
placed 50 feet apart, one behind the other.*

Material, inch yellow pine boards.

Distance of 1st. or nearest target, 1000 yds.

*Firing shrapnel; each containing 168 lead balls of
0.69 in. cal.*

Total weight of projectile, 32 lbs.

Bursting charge, 3 ozs.

Schenkl's percussion fuze.

Four rounds fired deliberately.

Charge, 3 lbs.

Elevation, 2°50'

No of balls fired, 672.

No. of hits, 334.

1st. Round burst 100 feet in front of 1st. target.

Time of bursting, 3".75.

2nd. Round did not burst.

3rd. Round burst in front of 7th. target.

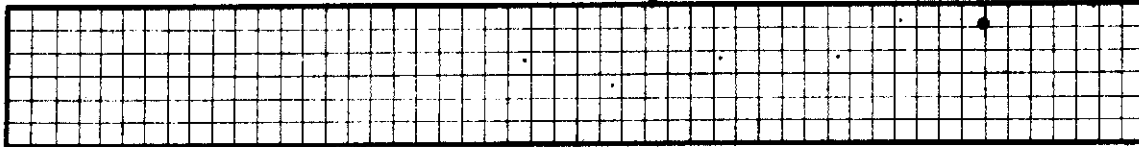
Time of bursting, 3".75.

4th. Round burst above the column.

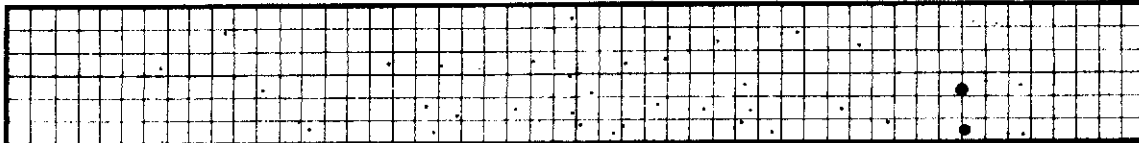
*Wind oblique to line of fire, from left to right and
ahead, eight to ten miles per hour.*

TRIAL No. 29.

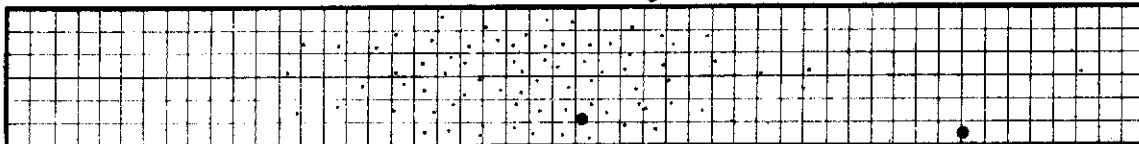
10th. Target.



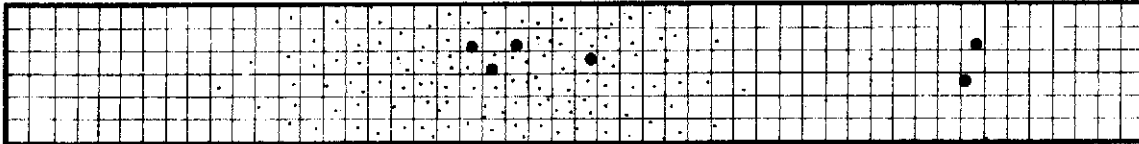
9th. Target.



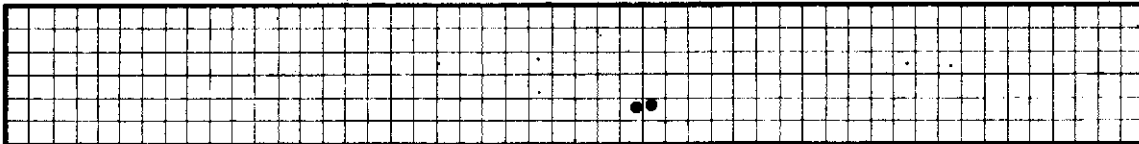
8th. Target.



7th. Target.



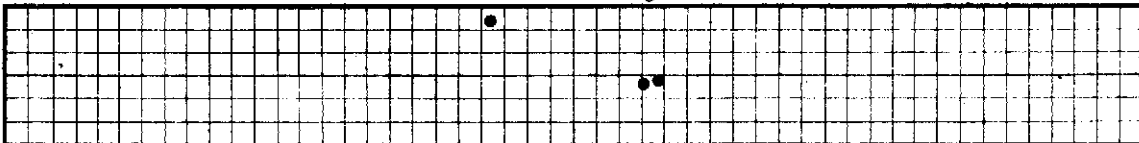
6th. Target.



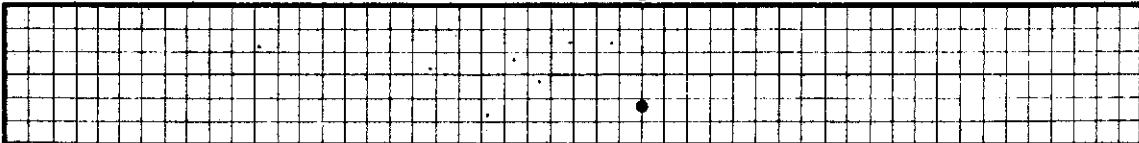
5th. Target.



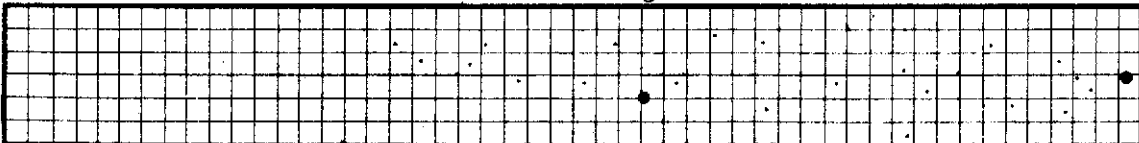
4th. Target.



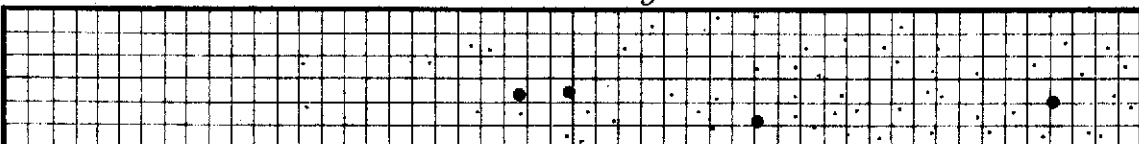
3rd. Target.



2nd. Target.



1st. Target.



TRIAL No. 30.

4 1/2 in. Rifled Siege Gun.

*Column of ten board targets, each 6 feet by 50 feet,
placed 50 feet apart, one behind the other.*

Material, inch yellow pine boards.

Distance of 1st. or nearest target, 1000 yds.

*Firing shrapnel; each containing 168 lead balls of
0.69 in. cal.*

Total weight of projectile, 32 lbs.

Bursting charge, 3 ozs.

Schenkl's percussion fuze.

Four rounds fired deliberately.

Charge, 3 lbs.

Elevation, 2°45'.

No. of balls fired, 672.

No. of hits, 164.

1st. Round burst in front and to the right of 1st. target.

Time of bursting, 3"3

2nd. Round burst in front and to the right of 1st. target.

Time of bursting, 3"

3rd. Round burst in front and to the right of 1st. target.

Time of bursting, 3"15.

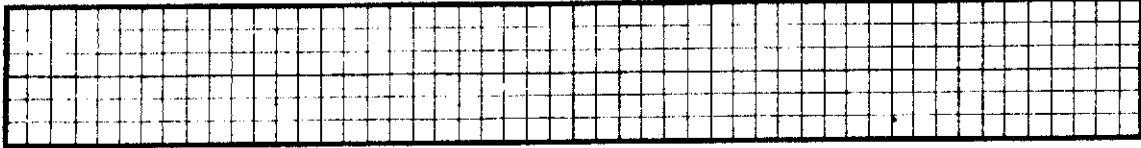
4th. Round burst beyond 1st. target.

Time of bursting, 3"45.

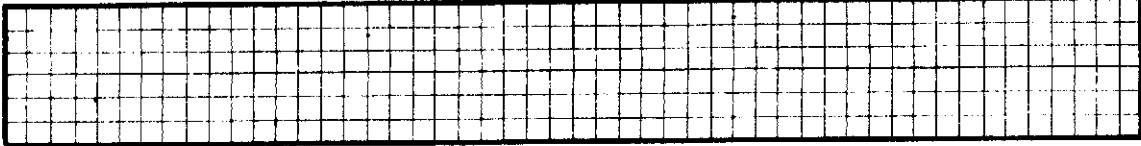
*Wind obliquely across line of fire, from left to right and
ahead, eight to ten miles per hour, variable.*

TRIAL No. 30.

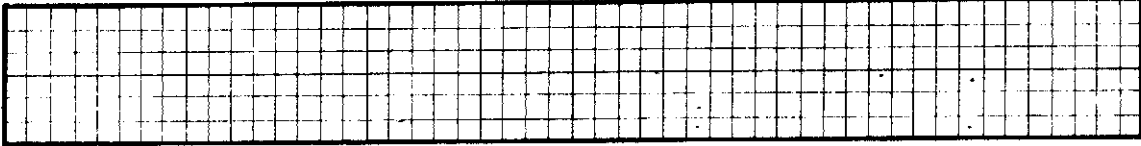
10th. Target.



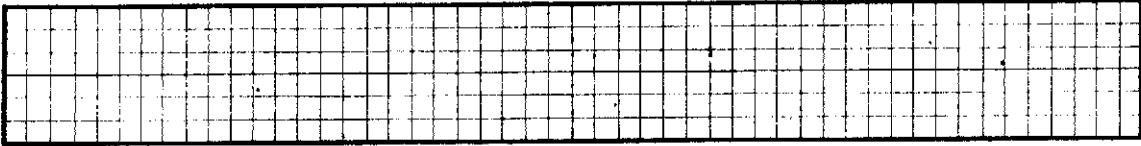
9th. Target.



8th. Target.



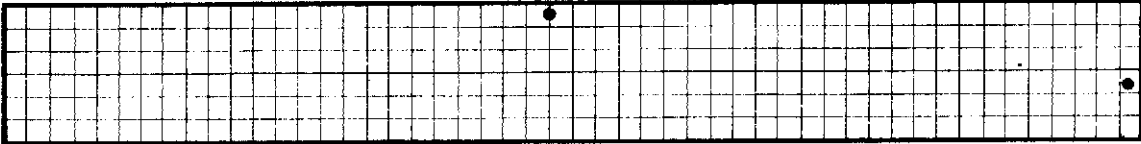
7th. Target.



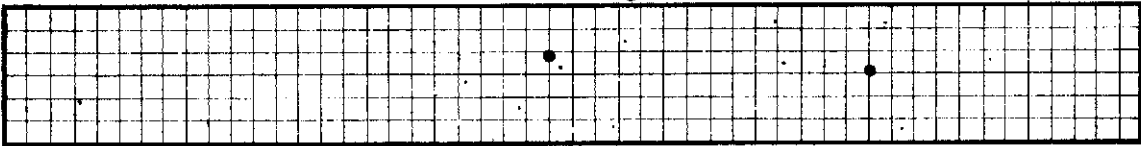
6th. Target.



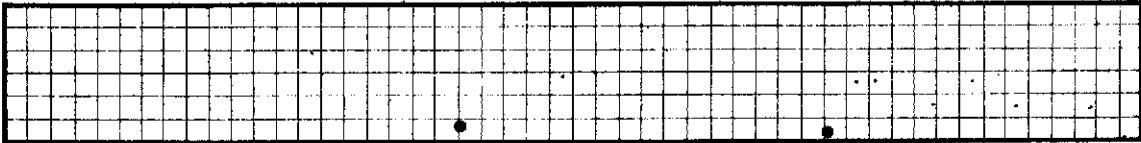
5th. Target.



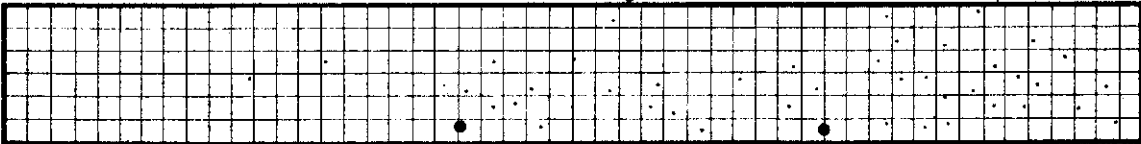
4th. Target.



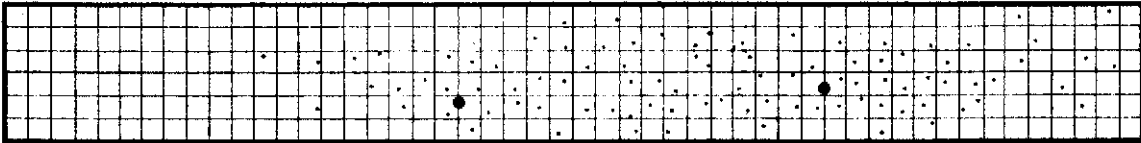
3rd. Target.



2nd. Target.



1st. Target.



TRIAL No. 31.

8 in. Siege Howitzer.

*Column of ten board targets, each 6 feet by 50 feet,
placed 50 feet apart, one behind the other.*

Material, inch yellow pine boards.

Distance of 1st. or nearest target, 1000 yds.

*Firing spherical case shot; each containing 470 lead
balls of 0.69 in. cal.—Weight of projectile, 60 lbs. 3 ozs.*

Bursting charge, 15 ozs.

Time fuze, paper, 4½ seconds.

Four rounds fired deliberately.

Charge, 6 lbs.

Elevation, 6°10'.

No. of balls fired, 1880.

No. of hits, 615.

1st. Round burst to right and high.

Time of bursting, 5"25.

2nd. Round burst to right of target; lost.

Time of bursting, 5"20.

3rd. Round burst to right and high.

Time of bursting, 5"

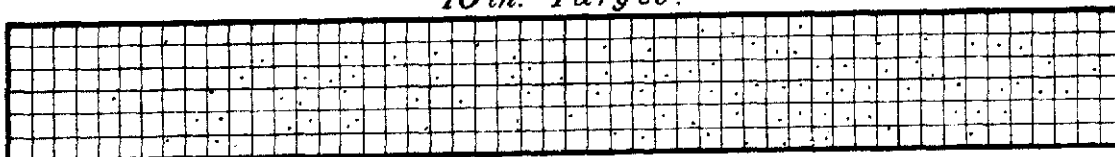
4th. Round burst to right and struck ground in front.

Time of bursting, 5"

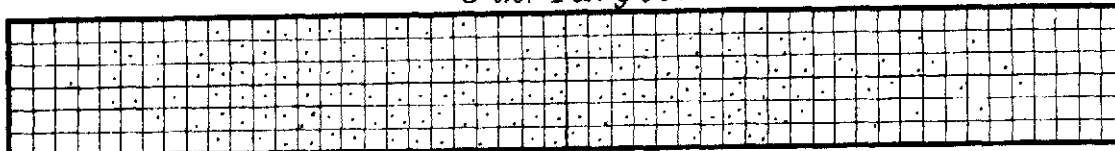
*Wind across line of fire from left to right, eight miles
per hour.*

TRIAL No. 31.

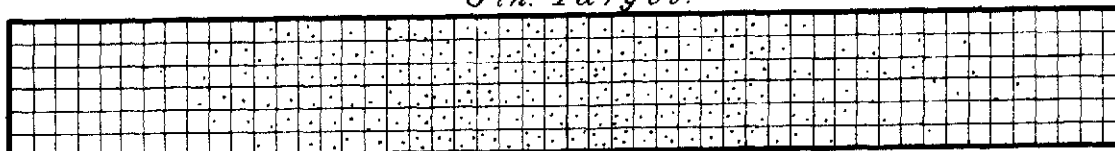
10th. Target.



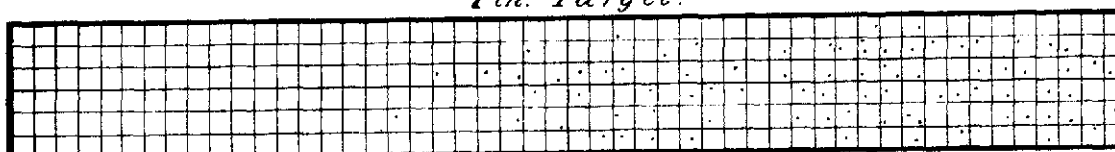
9th. Target.



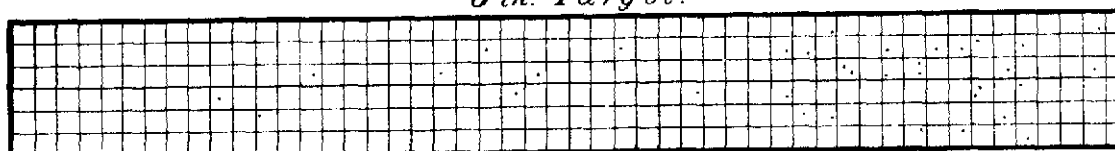
8th. Target.



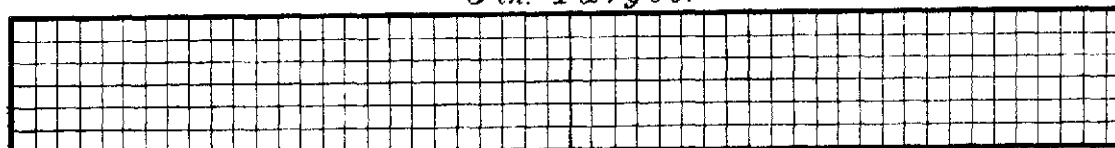
7th. Target.



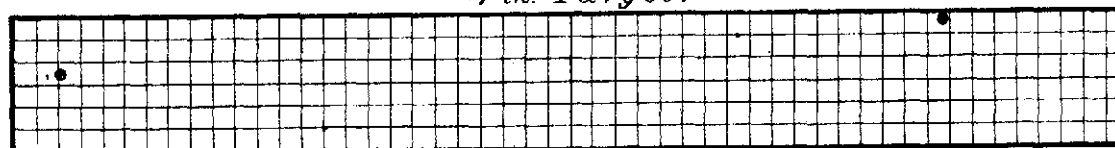
6th. Target.



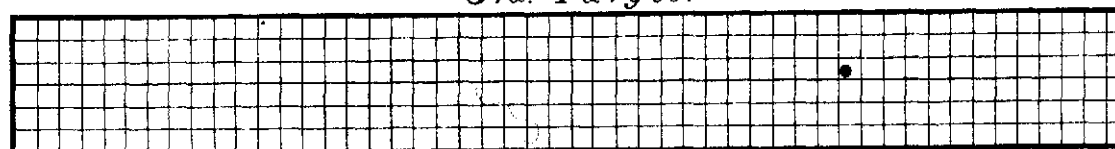
5th. Target.



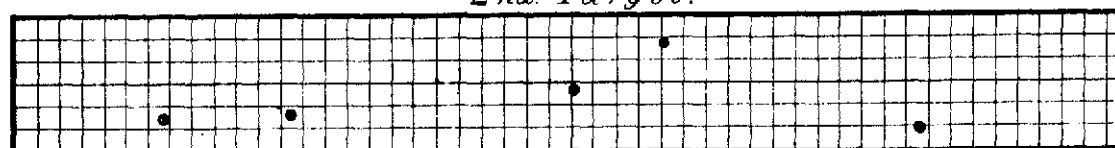
4th. Target.



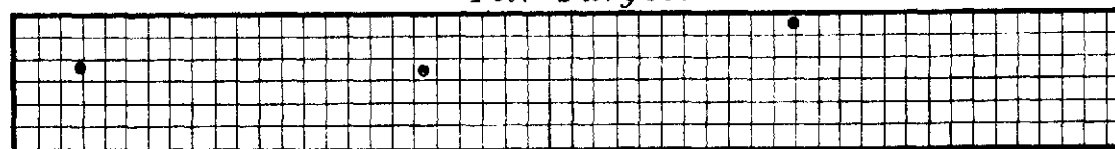
3rd. Target.



2nd. Target.



1st. Target.



TRIAL No. 32.

8 in. Siege Howitzer

*Column of ten board targets, each 6 feet by 50 feet,
placed 50 feet apart, one behind the other.*

Material, inch yellow pine boards.

Distance of 1st. or nearest target, 1000 yds.

*Firing spherical case shot, each containing 470 lead
balls of 0.69 in. cal.—Weight of projectile, 60 lbs. 3 ozs.*

Bursting charge, 15 ozs.

Time fuze, paper, $4\frac{1}{2}$ seconds.

Four rounds fired deliberately.

Charge, 6 lbs.

Elevation, $6^{\circ}10'$.

No. of balls fired, 1880.

No. of hits, 407.

1st. Round:

Elevation, $6^{\circ}10'$.

Fuze, $4\frac{1}{2}$ seconds.

Time of bursting, 5.25 seconds.

2nd. Round:

Elevation, $6^{\circ}10'$.

Fuze, $4\frac{1}{2}$ seconds.

Time of bursting, 5.25 seconds.

3rd. Round:

Elevation, $6^{\circ}10'$.

Fuze, $4\frac{1}{2}$ seconds.

Time of bursting, 5.5 seconds.

4th. Round:

Elevation, 6° .

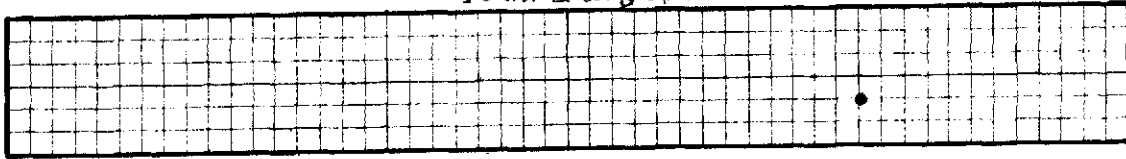
Fuze, $4\frac{1}{4}$ seconds.

Time of bursting, 4.75 seconds.

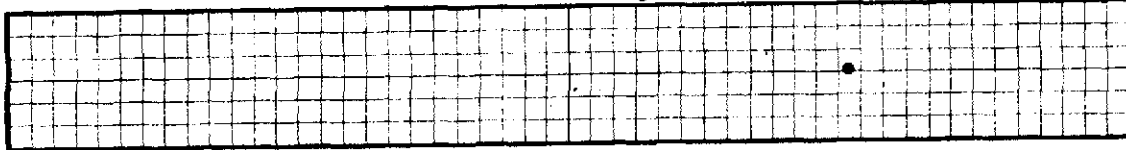
Only one shell burst within the column.

TRIAL No. 32.

10th. Target.



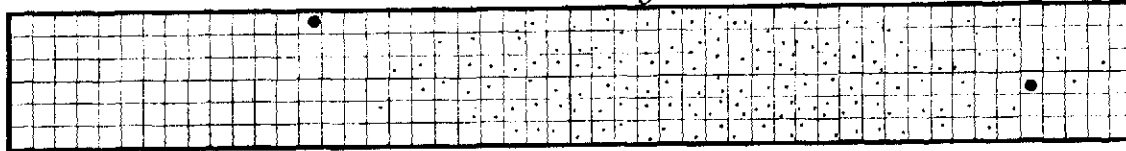
9th. Target.



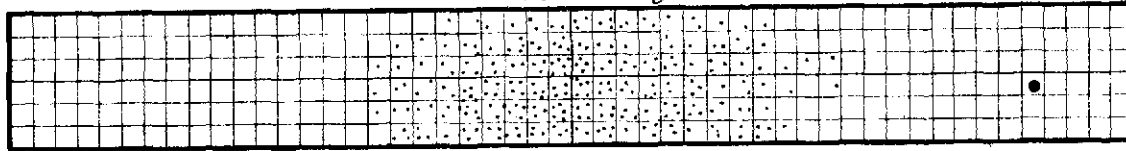
8th. Target.



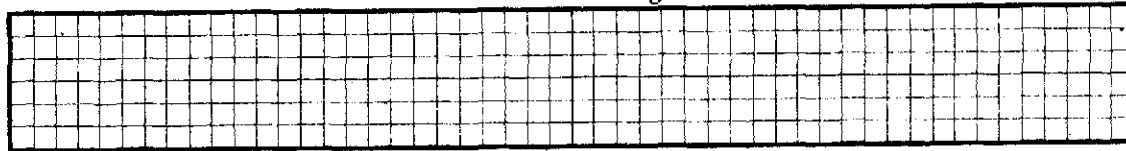
7th. Target.



6th. Target.



5th. Target.



4th. Target.



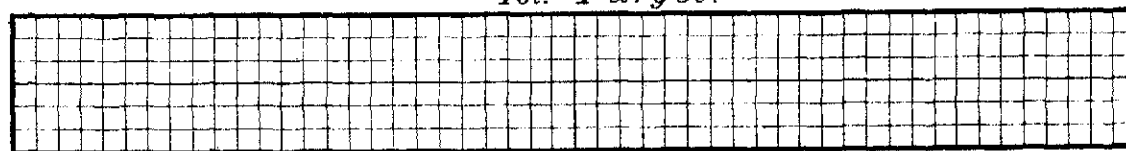
3rd. Target.



2nd. Target.



1st. Target.



TRIAL No. 33.

Gatling 10 barrel gun of 0.42 in. cal.

*Column of ten board targets, each 6 feet by 50 feet,
placed 50 feet apart, one behind the other, representing
a column of companies approaching gun.*

Material, inch yellow pine boards.

Distance of 1st. or nearest target, 1000 yds.

Firing single solid shot, with upright cases, deliberately.

40 balls in each case.

Elevation, 2°.

No. of shots fired, 600.

No. of hits, 526.

The aim was too low in this case.

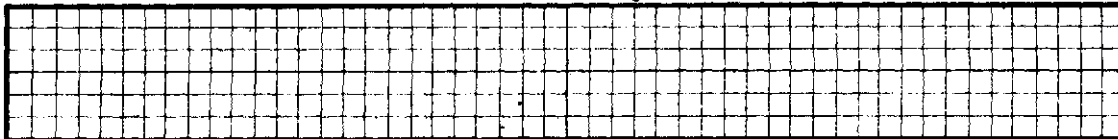
*Wind from left to right across line of fire, four miles
per hour.*

TRIAL No. 33.

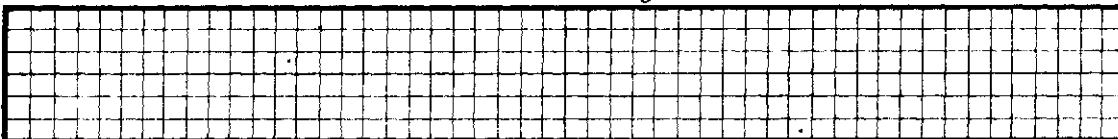
10th. Target.



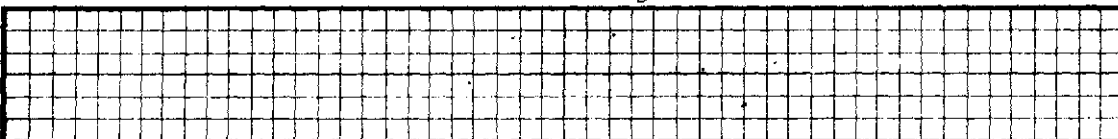
9th. Target.



8th. Target.



7th. Target.



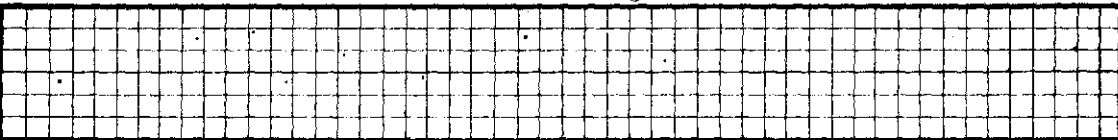
6th. Target.



5th. Target.



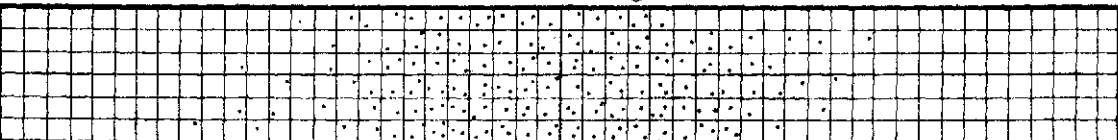
4th. Target.



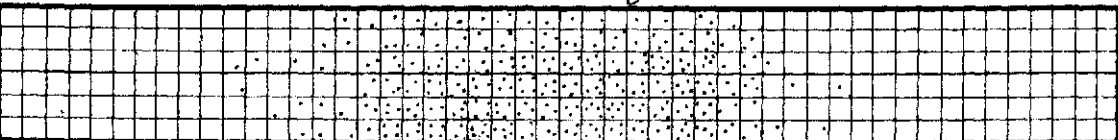
3rd. Target.



2nd. Target.



1st. Target.



TRIAL No. 34.

Gatling 10 barrel gun of 0.42 in. cal.

*Column of ten board targets , each 6 feet by 50 feet,
placed 50 feet apart , one behind the other, representing
a column of companies approaching gun.*

Material, inch yellow pine boards.

Distance of 1st. or nearest target, 1000 yds.

Firing single solid shot with upright cases, deliberately.

40 balls in each case.

Elevation , 2°30'.

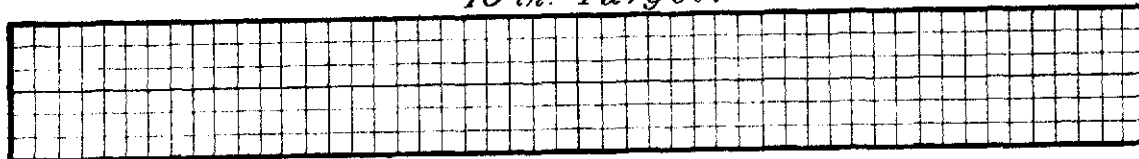
No. of shots fired , 600.

No. of hits , 691.

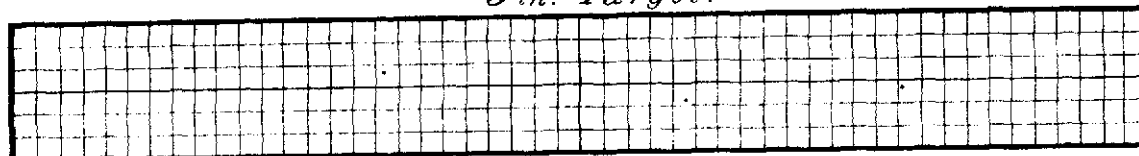
*Wind from left to right across line of fire , four miles
per hour.*

TRIAL No. 34.

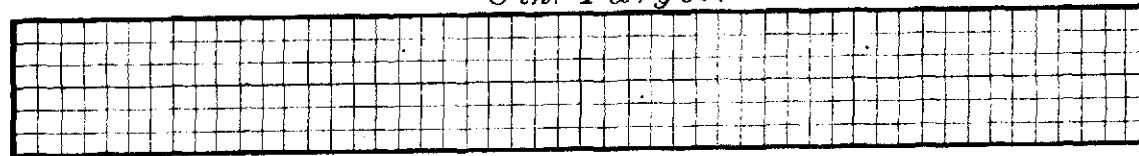
10th. Target.



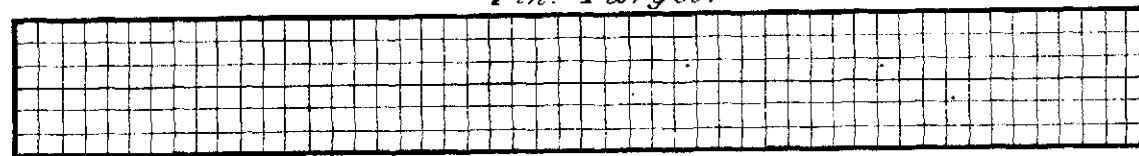
9th. Target.



8th. Target.



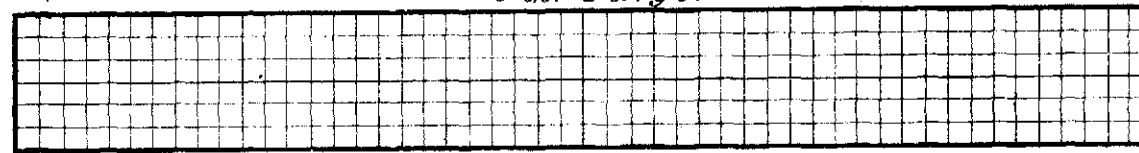
7th. Target.



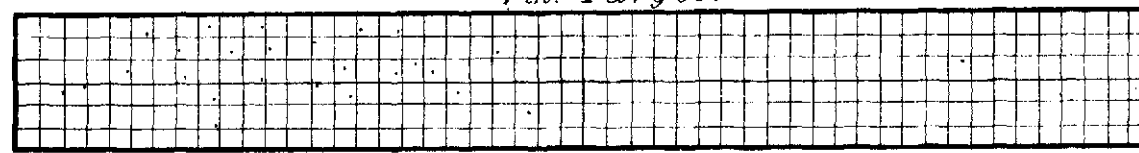
6th. Target.



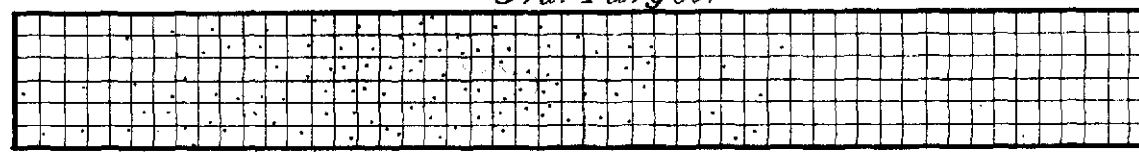
5th. Target.



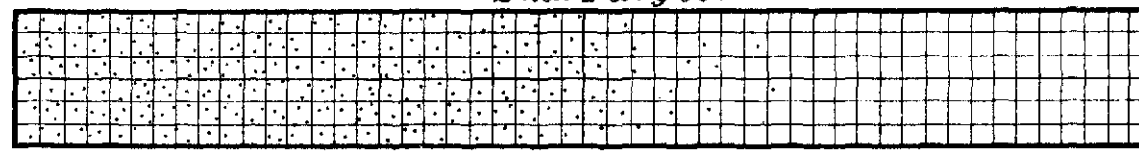
4th. Target.



3rd. Target.



2nd. Target.



1st. Target.

